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INFANT DIET

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Jacobi;

INFANT DIET

A LECTURE

BY

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BY

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At a recent meeting of the Public Health Association of New York, it was voted "that Dr. A. Jacobi be requested to furnish for the use of the Association a Schedule of Directions concerning infantile diet in summer, and to present the subject for discussion at a future meeting of the Association."

The meeting was held at the rooms of the Medical Journal Association, May 8, 1873.

PREFACE BY THE EDITOR.

WHAT should be the nature of a popular essay? To judge by the multitude of little books that are lavished upon young mothers to help them in the care of their children, one thing is supposed to be fundamental—theory, or an explanation of scientific basis for the precepts laid down, must be rigidly avoided. "However this may be," observes Fonssagrives, "the physiological theory is of no importance to the mother; all that concerns her, is the fact." Now we assume, contrary to this dictum, that the theory of a fact does concern every intelligent person who is interested in its application. We consider that a popular essay must differ from a scientific treatise—1st. By the use of non-technical language, and consequently by the sacrifice of the concise style that enables so much to be concentrated in so few words. 2d. By a careful explanation of things assumed to be known by persons conversant with the science, and to whom such explanation would therefore be impertinent. 3d. By restriction within the limits of what is already positively assured to science, and by the absence of the new researches or the original criticism which alone constitute the *raison d'être* of a book professing to be scientific. These conditions narrow the scope of a popular essay, but do not necessarily render its direction different from any other that professes to convey information. The information that can be given is in proportion to the technical abbreviations which may be employed, and inversely to what is already known; and hence, as the popular reader is presumably ignorant of the subject-matter, only a comparatively small amount of knowledge can be conveyed to him. But what is told should be the same in kind as what is told to the scholar. Few women seem to be aware of the insult implied in the assertion "that the theory is of no importance to them." Of whomsoever this assertion may be truthfully made, it must be said that he is destitute of the highest characteristic of an intelligent being—the desire, namely, "to understand himself and the things around him." It is true that, without technical education, no mother can fully understand physiological laws.

nor be able to deduce from them all the practical rules that are necessary for guidance in health, and still less in disease. But, like the intelligent passenger on a vessel, who learns how to read the chart and to foresee the directions and incidents of the voyage, even while submitting to the control of the captain, so the mother may learn the general plan of her child's life, its future course, and the accidents that beset it, and, in regard to the details to which her attention is called, learn much, if not all, of their scientific relations. For these mean simply the *exact* relations of things to each other, of effects to causes, of appearances to underlying conditions, of actions to organs, of vital phenomena to the physiological laws of the body in which they occur.

This little book is not a mother's manual, nor a treatise intended to exhaust the vast topic of the development of infant life. To understand only a small part of what is known about that, the mother must consult, not one little volume, but many big books. Of all the questions that might be asked in relation to the child, we only propose to answer one—namely, "What shall it eat?" But this is fundamental to all others, as is to the farmer the nature of the soil whence his seed may obtain the materials for its growth. The roots of the plant lie outside its body, but in the infant's body the roots are inside, lining in infinite number the walls of the stomach and intestine, whence they reach down into the fluids that fill these canals, and draw up nourishment to be absorbed into the blood. So long as the food is still in the digestive tube, it is as much outside the body as are the salts in the earth penetrated by the rootlets of plants. Yet as the composition of that soil will determine the kind of plants that may spring from it, here wheat, there barley or oats—here the pine, there the luxuriant olive—so upon the substances that are introduced into the alimentary canal, and on the chemical changes that take place there, largely depends the character of all the tissues of the body. In a plant, where the life is purely nutritive, that is, where there are no functions involving muscles or nerves, it is much easier to study the relations between the food and the tissues, than it is in an animal, in whom these relations are so incessantly modified by the influence of the nervous system. We analyze what is absorbed by the leaves and the roots, what is exhaled from the leaves again, and finally the substance of which the plant is composed, and we can then judge pretty well of the nature of the changes through which the food has passed during the building up of the body of the plant. But in an animal, the action of the nerves and muscles determine other changes than those needed for the transformation of food into tissues, and on this account the problem is greatly complicated. Now, in comparison to the life of the adult, the life of a baby approaches to that of a plant. It has, indeed, a nervous system, and one exquisitely susceptible to influences brought to bear upon it from without, and especially to those that affect the two great surfaces of the body, the skin and the mucous membrane of the digestive canal. But this nervous system does not, like that of the adult, *originate* actions whose intensity is constantly liable to disturb the processes of nutrition. Thus, in an adult, dyspepsia is most frequently induced by exhaustion of the nervous system consequent upon over-work, by fatigues, depressing emotions, anxieties, etc. These are all as foreign to the tranquil life of the child as to the slumbering consciousness of wood anemones. But in the child, the same dyspeptic symptoms will be caused by ill-assorted food, acid fermentation in the stomach and bowels, and the nervous system, blameless as a cause of the disease, will suffer so violently from its effects, that life may be destroyed in convulsions.

On this account, the food in children is, relatively to other things, of more importance than the food of adults: also their health is more readily affected, their diseases more readily controlled, by substances which determine in the digestive canal known chemical reactions; whereas in adults we are more often obliged to arrive at these same results indirectly, by means of agents that exercise their first influence on the nervous system, and whose chemical reactions are too little understood to be utilized.

In the following pages we endeavor to set forth some of the more assured facts in the possession of science in regard to the chemical changes that take place in the infant economy during the processes of nutrition, and in regard to the means of averting morbid alterations in these changes.

INFANT DIET.

There was a time when no historical essay, either systematic or monographical, could be written without reference to Adam and Eve. With similar pertinacious appeal to first principles, have authors of treatises on the diet, physiology, or pathology of infants or children, considered themselves bound to prove by multitudinous facts, that breast-milk is the indispensable food for newborn or for young infants. Now there are some truths which ought by this time to be taken as axioms, and whose fresh demonstration seems to me superfluous. I shall take it as granted that mother's milk is the most appropriate food for an infant in all its stages of gradual development; that weaning ought not to take place before the infant and its digestive organs are sufficiently prepared for more complicated nutrition; that the gradual changes in the constitution of mother's milk are naturally adapted to the successive requirements of the growing infant; that, as a rule, the first indication of the necessity of adding artificial food to breast-milk, or replacing the latter by the former altogether, is offered by the appearance of the first teeth; that, when breast-milk is insufficient, food should be added or substituted which, as nearly as possible, resembles breast-milk.

Were Nature always adequate to the transaction of her own business and the fulfilment of her own wishes, she might be left to herself without interference, and we doctors especially would find our occupation gone. As scientists we should continue to study her processes and try to comprehend her laws; but then we should feel as little necessity for modifying the one or the other, as for changing the orbit of the planets, or the path of the earth around the sun. We agree, at all events, to consider perfect such parts of the universe as lie entirely beyond our control; and even when this agreement is purely conventional, it at least secures resignation to the inevitable.

In regard to the details of human life, however, we are at once more skeptical and more hopeful: the imperfections and failures in the unassisted working of natural laws are forced more conspicuously upon our attention, and we are more willing to admit their existence, because we feel more able to control their consequences. An excess of optimism is here extremely prejudicial, for it tends to arrest criticism and to paralyze efforts which are really needed to avert disaster. Eloquence is well expended upon the beauty and advantages of maternal nursing, when this may be carried on in suitable conditions; but it is very certain that these conditions are often extremely unsuitable, and that the mother's milk may be as unreliable in quantity, or as widely removed in quality from the physiological type of nourishment required by the infant, as could be the most badly prepared artificial food. Sometimes the chemical composition of human milk is altered, and the proportion between its different constituents, salts, butter, cheese, sugar, water, changes to that characteristic of the milk of other animals. In this case, the nursling at the breast is exposed to precisely the same inconveniences as a bottle-fed child, brought up on alien food. In other cases, the alterations in the milk, through inappreciable to our chemical analysis, is even more injurious than those which are. It is caused by the existence in the mother of certain constitutional diseases, which affect the milk, as every other secretion of the body, and may render it a slow poison for the child. Or, without positive disease, the constitution of the mother may be weakly, and deteriorate still further under the nursing. The maternal milk then tends to confirm or increase the vices of nutrition already conveyed to the child by way of inheritance. It is often urged as an argument for the expediency of maternal nursing whenever the mother has a drop of milk in her breasts, that the mother's milk must be the more easily assimilable than any other by the child, because it is elaborated from the same blood as has furnished the materials for building up the child's body. This very resemblance is a disadvantage in the cases supposed, where it is desirable to counteract the original tendencies of the constitution, and to build up tissues in the child as different as possible from those of the mother. It is, however, often true that a child will assimilate its mother's milk better than that of any other woman, and will therefore thrive better upon it, although it be in itself less nutritious. It is well known to physicians, but much less well known than it should be to the public, that the nutritious value of food depends partly on its composition, partly on the facility with which it may be absorbed and assimilated; and circumstances that favor this assimilation may sometimes increase the nutritive value of the less well-composed food over that of the better. But cases are, on the whole, exceptional, where the milk of a weakly mother is really more advantageous for the child than that of a healthy wet-nurse or than suitably prepared artificial food. Many a mother raises at her own breast sickly, bloated, rachitical children, until finally one is born that she is quite unable to nurse: then for the first time appears in the family a noisy, ruddy, muscular baby.

There are two other conditions, besides those enumerated above, which contraindicate maternal nursing; namely, the occurrence in the mother of either menstruation or pregnancy. These are not so rare as might be supposed from some statements, or from the habit which prevails among many mothers, especially of the poorer class, of prolonging lactation in order to avoid the recurrence of pregnancy. An English writer has even advised working mothers to nurse their children during four years, so that, on the one hand, the children may be fed nutritiously and economically, and on the other hand, the mothers may be saved from the strain of excessive child-bearing, and society from the evils of over-population. This philanthropist does not reckon upon the exhaustion occasioned by excessive lactation, and which, as will be presently shown, profoundly deteriorates the nutritive character of the milk. But, apart from this consideration, the value of the suggestion is greatly lessened by the fact that many women retain their aptitude for conception throughout the nursing period, and the great majority regain it at a definite time from the birth of the child, whether the nursing be persisted in or not. This time generally corresponds to that which may be regarded as the proper duration for nursing—namely, from nine to twelve months; but the epoch may occur at four, five, or six months, or may be deferred to eighteen, or later. On the other hand, it often happens that women who do not nurse, do not recover their aptitude for conception until six or eight months after the birth of a child, and are therefore, in this respect, in the same condition as nursing mothers. From these facts it would appear that the activity of the mammary glands does not absolutely determine a period of inactivity in the ovaries and uterus, but rather corresponds to such a period, that is self-determined, and variable in each individual case;—that in many cases, it is true, this inaptitude seems to be increased by the activity of the other organs of the reproductive system, the mammary glands; but even this influence, which sometimes does not exist at all, is always restrained within fixed limits. Beyond these limits, the voluntary stimulation of the glands by keeping the child at the breast may indeed secure the secretion of some kind of milk; but the ovaries and uterus regain their independence, menstruation may return, or a pregnancy occur. Indeed, it is not absolutely rare to find women menstruating, nursing, and pregnant, all at the same time. We have here no statistics to quote, but we believe that, except in countries where the institution of polygamy favors the complete isolation of the woman during the period of lactation, the continuance of this function beyond twelve months has, in the majority of cases, no effect upon preventing the occurrence of a new pregnancy.

It is worth while to go back, and analyze some of the conditions which have been enumerated as rendering maternal nursing undesirable or impossible.

Women of the most various constitutions may be unable to nurse from absolute deficiency of milk; and it is well known that a robust woman may fail completely, while her fragile neighbor brings up at her breast a thriving child. Health is a relative term, and the general health of the body is quite compatible with defective development of one or more of its parts. Thus, even well-formed breasts may contain diminutive milk glands, whose imperfection is concealed by the abundant adipose tissue lying under the skin. Again, the glands may be sufficiently large, yet their activity be continually interfered with by the irritable condition of the nervous system. The secretion of milk depends on the equable flow of blood through the blood-vessels of the glands, and this is maintained when the blood-vessels stay open to just the right degree. The blood-vessels are encircled by rings of muscular fibre, and when these are made to contract by irritation of the nerves going to them, the blood-vessels are spasmodically closed, the circulation of the gland is disturbed, and the secretion of milk arrested. On this account, depressing emotions, and irritative excitement, especially anxiety about nursing, will stop the flow of milk, and, if long continued, may cause it to entirely "dry up." The stimulating effect on the secretion of milk exercised by the agreeable emotions, is well known to every mother. When the whole nervous system is equably stimulated, there is no such undue concentration of stimulus upon the nerves of the glands as may cause irritation with spasmodic closure of the blood-vessels. Again, the secretion of milk, which takes place chiefly when the child is put to the breast, demands, like all secretions, a certain influx of nerve force, or innervation, to the gland. Whenever the nervous system is weak, the intermittent action of nerves is attended by pain; and hence the act of nursing may occasion severe neuralgic pains through the breast and back, quite independent of cracks in the nipples, to which they are generally attributed.

A third evil influence of an excitable nervous temperament may be manifested in the quality of the milk, which, under violent emotions, may be so altered as to become a positive poison to the child. Generally, the effects of such alteration are confined to digestive disturbance, to vomiting, colic, purging. But in some rare cases, whose record is famous, a child put to the breast of a woman still agitated by violent excitement, has been seized with convulsions, or has even died suddenly, without the warning of any symptoms whatever. In these cases a virulent ferment seems to have been generated in the milk, analagous in the intensity of its action to that formed in the saliva of hydrophobic dogs, and whose malignity varies according to its abundance and to the mass of milk that had been decomposed under its influence.

For all these reasons, a woman with a markedly nervous temperament is generally unsuitable for the office of nursing; since her milk is liable to become deficient in quantity or perverted in quality.

Again, though the mother have plenty, the child may be deprived of milk from inability to nurse; in other words, on account of conditions which interfere with the mechanism of suction. Their precise influence is to be appreciated by reference to its details. When the child seizes the nipple, the lips, fitting accurately around it, close the cavity of the mouth in front, while, behind, this cavity is closed by the soft palate, which falls like a curtain upon the root of the tongue. The tongue arches so as to touch the roof of the mouth, and the cavity is thus completely filled up, as the cylinder of a pump is filled by the piston. When the child begins to suck, the tongue is drawn back, just as the piston would be, and for the same purpose, to create a vacuum in the space left between its tip and the lips. Into this vacuum the milk is forced from the nipple by the pressure of the atmosphere on the breast. As soon as the space is filled, the milk is thrown to the back of the mouth by the tongue, which abandons for this purpose its office as piston, the soft palate is lifted up to a level with the roof of the mouth, thus closing the communication with the nose, and the milk falls into the throat, there exciting automatic contractions of the muscles of the pharynx, that occasion a distinct sound of deglutition. This movement of deglutition alternates therefore with that of suction.

Now, if the child have a harelip, the nipple cannot be accurately embraced, the cavity of the mouth is left open in front, and the vacuum cannot be formed. In cleft palate, a fissure runs along the roof of the mouth, opening a communication with the nose, and the vacuum is again spoiled, because the cavity is left open above. When the tongue is tied, i. e. bound down to the floor of the mouth, behind the gums, it cannot retract sufficiently to fulfil the office of piston. In all these cases, therefore, the vacuum is imperfect, and therefore the milk is imperfectly pressed out of the milk ducts into the baby's mouth. The difficulty is purely mechanical. But again, in certain cases of profound debility, such as occur in children that have been born prematurely, the child may be incapable of the muscular effort necessary to close the lips and move the tongue, and nursing is therefore again rendered impossible.

The so-called "vital" changes in the chemical composition of the milk, dependent on distinct disease, are especially to be dreaded when the mother is affected with consumption, syphilis, epilepsy, or chronic eruptions. When the mother has a flabby, lymphatic constitution, without actual disease, or when there is anemia, i. e. impoverishment of the blood, induced by over-work, insufficient food, or prolonged lactation, the solid constituents of the milk are generally diminished. The milk of an anemic woman who had been bled several times during pregnancy, showed a marked diminution of caseine and sugar, with an increase of butter. This latter fact is quite remarkable, and of importance, because the nutritive value of milk is generally estimated by the proportion of fat alone. As will be presently shown, the fat in milk is formed in the cells lining the ducts of the glands, from the caseine and sugar. In many cases of perverted nutrition, an excess of albuminous and saccharine material is converted into fat, and it is possible that the excess of fat found in this analysis was due to such morbid metamorphosis. In another anemic woman, who had suffered from uterine hemorrhages, the caseine, butter, and sugar were all diminished, together with some of the salts (phosphates). In other words, the milk was more watery—just as the blood is after hemorrhage. Both the children were rickety. In a third case, where the child was extremely rickety, and died on the fifty-third day, the sugar was in normal proportion, but the caseine and butter were diminished, and there were only traces of earthy salts.

Analyses of milk are so rarely made in comparison to the frequency with which its altered composition is evidently the cause of ill health in the nursling, that we do not yet know precisely when and how it is modified

Still some facts have been acquired, and may be stated as follows:—The water is *in excess*, i. e. the solid constituents are diminished *en masse*, when the proportion of water in the blood is increased—thus after hemorrhages, artificial bleeding, in some kidney diseases, and in some forms of anemia. The milk is less nutritious because *watered*. The water is *diminished*, in forms of anemia where the mass of blood is diminished; in very hot weather, causing excessive perspiration; in fevers; and during menstruation, if that occur in the period of lactation. In the last case, the diminution depends on the derivation to the uterus of blood from the blood-vessels of the mammary glands, thus diminishing the supply from which the water of the milk is to be transuded.

The quantity of caseine is, other things being equal, in inverse proportion to that of the water, and is therefore increased in all the above cases. During menstruation, the cells of the ducts which secrete the albumen, sugar, and salts from the blood, continue their function even when less water transudes from the blood-vessels, and hence the solid ingredients of the milk increase out of proportion to the aqueous. The milk is said to be more concentrated, resembles cow's milk, and is digested with difficulty by the child for the same reason as the latter. The quantity of caseine may be readily estimated by curdling skimmed milk with acid, washing the curds repeatedly to free them from sugar and salts, drying, and weighing the residue.

Deficiency of butter frequently occurs in poor, watery milk, found in the breasts of anemic women, ill fed, or debilitated from other causes. Yet, as we have seen, in some such cases, there is an excess of butter in proportion to the other solid ingredients; but it is highly probable that then the butter is not of normal quality, but results from the fatty degeneration of the albuminous ingredients of the milk. Albumen is very liable to become converted into fat as a result of perverted nutrition, and in this way the muscles of the limbs or the muscular fibre of the heart becomes fatty, or "suffers fatty degeneration." The same change may take place in the albumen of the milk.

The butter of milk is not dissolved in the water of milk, as are the caseine, sugar, and salts, but floats in the form of microscopic round globules, called fat globules. These are very characteristic of milk, and upon their variations in number or appearance are based the most usual methods for estimating the richness of the milk. It is they which give the peculiar opaque whiteness to the fluid, and this is more marked in proportion to their abundance. On this account, cow's milk, which is very rich in butter, is extremely white and thick, while human milk, which contains less butter and more sugar, is bluish and semi-transparent. The milk secreted immediately after childbirth has much fewer fat globules than that which comes later. On the other hand, it contains some large cells, filled with granulations, and called colostrum corpuscles. These should disappear from the milk within eight days after childbirth: if they persist longer, the milk is rendered unhealthy. When the milk has become unhealthy from exhausting disease in the mother, these colostrum corpuscles sometimes reappear.

The fine granules contained in the colostrum cells are fat granulations, while in the butter globules the fat is collected into one large drop of oil, which completely fills the cell. The colostrum is an early stage in the development of fat globules. The lactometer of Donné is an instrument with which the number of fat globules may be estimated from the color they give to thin layers of milk. It is very important to remember that milk may respond to this test, and yet be insufficiently nutritious from lack of other materials. The deficiency of butter does, however, seriously impair the nutritive value of the milk, for fats play a most important part in the nutrition. When burned or oxidized in the blood, they evolve a very considerable amount of heat, nearly five times as much as meat, three times as much as bread, and twice as much as sugar or farinaceous food. This heat is as necessary for the growth of the tissues in the baby's body as for the growth of seeds in the ground. Again, when fat is mixed with albuminous substances in the stomach, as with the caseine of the milk, the digestion of the latter is facilitated. (Boussingault.)

When, therefore, there is not enough butter in the milk, the caseine present is digested with more difficulty, and the result is the same as if the caseine were in excess. The baby, therefore, will vomit solid curds, as if it were fed upon cow's milk. The same influence of fat upon the metamorphosis of albuminous substances is exercised in the blood: the plastic (building) materials, received from the food, cannot be converted into the tissues of the body without the presence of fat. Fat seems to be essential to the formation of new cells, whose nucleoli always contain fat, and there is more in young and rapidly growing tissues than in those whose growth has been slackened by maturity.

It remains, therefore, in a soluble form, intimately associated with the elements of the tissues; and as these begin to decay, the fat accelerates the chemical changes which effect their decomposition, and hence the elimination of used-up material from the body. The nervous system is the part of the body where nutritive changes are the most rapid and complete, and it is here that fat principally abounds and is most tenaciously retained. From all this is evident the immense importance of fat in the nutrition of the rapidly growing infant body, and thus may be easily explained the emaciation that takes place in babies nourished by milk in which the fat globules are deficient. The function of sugar is partly the same as that of fat, that is, it contributes largely to the production of heat. Its heat-making power is only about one-half that of fat, but, during its passage through the body, sugar becomes partly converted into fat, and then it serves precisely the same purposes as the latter substance. Sugar is liable to ferment in the digestive canal, especially in the mouth, if long retained there, and then acids are formed which irritate the mucous membrane. Many cases of sore mouth in bottle-fed babies is due to the excess of sugar added to their food. In human milk, the sugar is rarely in excess, although this has been observed in the watery milk of anemic women. (Routh.) It is much more often deficient. The effects of such deficiency will be partly the same as we have noticed when butter was deficient—for the reason that sugar partly supplies the place of butter, and partly is converted into it. But other substances that result from the decomposition of sugar, are of importance in many ways. Lactic acid is formed in the stomach, helps to give acidity to the gastric juice, and thus assists in the digestion of caseine. It will be shown further on that the presence in the stomach of substances soluble in water, as sugar, accelerates the digestion of insoluble substances, as caseine. (Schiff.)

When food is digested rapidly in the stomach, it is thrown more rapidly into the intestine, and the peristaltic movements of the intestine are accelerated. But when food arrives too slowly in the intestine, it is stimulated too slowly to contract, and, to use the popular phrase, "the bowels become sluggish." It is probably in this way that milk in which sugar is deficient, frequently becomes a cause of constipation in the child; and that, on the other hand, infantile constipation may often be relieved by the addition of sugar to the food.* The diminution of sugar frequently coincides with a surplus of caseine.

The last constituents of the milk are the inorganic salts, chloride of sodium and of potassium, phosphate of potassa, iron and lime. In human milk all these together only amount to two and a half parts in a thousand, and at first sight it may be difficult to understand how mineral substances, and in such minute quantity, can be of any importance to the nutrition of the animal body. Yet each member of this group has a distinct function to perform, and if it be deficient the child will cease to thrive.

The chloride of sodium, or common salt, begins to play its part as soon as it reaches the stomach; for it is

* One or two scruples, about two-thirds of a teaspoonful, of loaf sugar, are dissolved in two teaspoonfuls of tepid water, and given just before nursing

decomposed by the glands of the stomach into soda and hydrochloric acid, the latter being the most important ingredient in the gastric juice. (Beneke.) The salt, therefore, both stimulates the glands to activity and furnishes the material upon which they may act. In this way it is a very powerful agent to increase the appetite. When the hydrochloric acid has fulfilled its duties in the stomach and passes into the intestine, it combines with a part of the soda of the bile to form chloride of sodium again, and this very reaction stimulates the secretion of bile. The presence of chloride of sodium in the fluids of the intestine regulates the diffusion of substances through the blood-vessels of the intestinal villi into the blood; and when the salt has passed into the blood, it again regulates the diffusion of material from the blood to the tissues, and from the serum of the blood to the blood corpuscles. The albuminous substances that must be absorbed from the intestine and finally fixed in the tissues, find great difficulty in passing through the walls of blood-vessels and of cells composed of material analogous to their own. These substances are called "colloid," or "jelly-like," on account of this difficulty of transfusion. On the other hand, substances that crystallize, mineral salts, and especially chloride of sodium, diffuse with great facility, and when they combine with albumen, they carry the latter along with them, first into the cells to build them up—then out of the cells, when the cell substance has become effete and must be re placed by new. This fact explains why all the solids and fluids of the body contain salt; for without it, no albuminous food could be taken up into the blood, nor pass from the blood to the tissues requiring it; nor, finally, could any dead tissue be eliminated from the tissues and excreted from the body. An increase of salt in the food increases the streaming of nutritive fluids in and out of the cells, and the rapidity of metamorphosis of albuminous substances, so that the nutrition is everywhere quickened. But if this increase be excessive, the destruction of tissues will be also excessive, too much albumen will be thrown out of the tissues, and diarrhœa will be set up in the effort to eliminate the effete matter, just as in starvation. In the "Journal for Diseases of Children" (1873) is related a case where the mother's milk contained 8 per cent. of salt, instead of .09 in a hundred parts (the normal amount), and the baby nearly died of inanition and its attendant diarrhœa. He was only saved by the substitution of a wet-nurse.

This influence upon diffusion is exercised by all the other mineral salts; but each of these has other uses as well. After chloride of sodium, the alkaline and earthy phosphates are the most important. The first consist of a combination of phosphoric acid with soda and potassa; in the latter, the same acid is combined with magnesia and lime. The phosphate of soda is a constant ingredient of the serum, or liquid mass of the blood; the phosphate of potassa is as constantly found in the red blood corpuscles, the little bodies that float in the serum and give it its characteristic color and vitality. The phosphate of potassa is also indispensable to the tissue of the muscles. When it is deficient, therefore, new red corpuscles cannot be built up, and the muscular tissue is imperfectly renewed, the blood is impoverished, and the muscles weak. They become soft and flabby, and the weakness of the muscles of the intestines is, in the child as in the adult, a frequent cause of constipation. The phosphate of soda in the serum of the blood affects muscular activity as decidedly, but in another way. When muscles are contracting, various substances contained in their juices are oxidized, or burned, and heat is evolved, as in every process of oxidation. This heat is converted into the force that moves the muscles, and without it the muscles could not contract at all. But by oxidation acids are formed in the substance of the muscles, that gradually accumulate and take the place of the more combustible substances, just as cinders accumulate in a grate as the coal is consumed. There is the same result in both cases—further oxidation becomes impossible—the production of heat is arrested, and the activity of the muscle stops as inevitably as does the work of a piston from which the supply of steam has been cut off. Moreover, the acids partially coagulate an albuminous substance in the muscles, so that these become stiff and painful. Hence the feeling of fatigue that follows muscular exertion, and which can only be relieved by washing away the acids and coagulated albumen with a stream of fresh blood. It is the phosphate of soda contained in the blood that neutralizes the acid and dissolves the coagulum, and thus restores the muscles to their freshness and vigor, and enables more heat to be generated. Deficiency of phosphate of soda, therefore, interferes with the action of the muscles, and thereby checks their development.

Again, the presence of this phosphate of soda in the serum is of importance to the processes of respiration, for it facilitates the absorption of carbonic acid from the tissues, and also the yielding up of this acid again from the blood which traverses the lungs. Finally, or rather at first, before entering the blood or reaching the muscles, the phosphate begins its *rôle* by favoring certain important details of digestion.

When the food passes out of the stomach into the intestine, it there meets with various fluids, by which, in different ways, it is modified. One of these fluids is secreted by a great gland called the pancreas, which lies behind the stomach, and, in edible animals, is known in the market as "the sweetbread." The pancreatic juice, as it is called, decomposes the fats of the food, and gylcerine, which is always contained in these fats, is set free. This glycerine should combine with the phosphoric acid derived from the phosphates that have also been present in the food, and form a peculiar product called glycero-phosphoric acid. This is absorbed, and aids the formation of cells in two different ways. In the first place it enters into the composition of a third substance called lecithine, which is essential to cell-formation in any tissue. In the second place, it passes into the cells of the cartilages, there meets with carbonate of lime, and with it forms phosphate of lime, by the aid of which the cartilage is gradually converted into bone.

Now all the steps of this process—decomposition of fats by the pancreatic juice, formation of glycero-phosphoric acid, of lecithine, and of phosphate of lime—may be arrested if the contents of the intestine are acid instead of alkaline, for the pancreatic juice only acts in presence of alkaline fluids. The phosphate of soda is one of the principal agents to maintain the alkalinity of the intestinal contents, and to neutralize the various acids which are liable to form during the process of digestion, and which become excessive as one of the first results of disturbance in digestion. Insufficiency of this salt, therefore, will first favor "acidity of the bowels," and ultimately interfere with the formation of tissues, and especially with the growth of bone. The earthy phosphates, especially the phosphate of lime, have a still closer relation to the growth of bone. The phosphate of lime is one of the most abundant salts of human milk, which contains in 100 parts about 0.25, or a quarter of 1 per cent. "No cell-formation takes place without phosphate of lime," says Beneke. And phosphate of lime is especially needed to build up the bones, and to give them the solidity by which they are distinguished from all the other parts of the body. We have just shown that the bony phosphates are partly formed in the cartilages at the expense of other combinations of lime on the one side, and of phosphoric acid on the other. But they are partly also derived directly from phosphate of lime that is taken in the food and brought to the growing bones by the blood, to combine with organic substances and build up bone tissue.

The relations of the phosphates to different processes of nutrition are thus seen to be extremely numerous and important. When they are deficient, the nutrition must suffer seriously, and more in young and growing animals than in others—more, therefore, in the baby than in the adult. The baby is exposed to one disease peculiar to infancy, and which, though not exclusively due to errors in diet, is still frequently traceable to them. This disease is rickets, once known as the "English disease," and supposed to prevail principally among the children of the wealthy, luxurious, and dissipated classes. It is now known to be much more common among the poor. It is a disease affecting the nutrition of the entire body, because it implies a deficiency of phosphates, and consequently imperfect development of all the tissues to whose growth the phosphates have been shown to be so important. There are too few blood corpuscles, the muscles do not grow and cannot work, the bones remain soft and only half organized. The child is therefore anemic, from impoverishment of the blood, its flesh is white and flabby, the muscles soft and nerveless, the bowels constipated, the power of walking retarded. The most striking visible results of the rickety perversions of nutrition are seen in the bones, and as consequences of the abnormal flexibility caused by the deficiency of lime. The head is large and unwieldly, and spreads out of shape, the brain is exposed unduly to external pressure on the softened skull, and convulsions and "crowing croup" may be caused by such irritation. The chest is flattened on each side by the pressure of air upon the softened ribs; the breast bone is pushed forward, forming the so-called "pigeon breast," and the lungs are so crowded for room that respiration is seriously impeded. This impediment to respiration, again, interferes with the oxygenation of the blood, and thus renders it less nutritious. It also greatly enhances the danger of every attack of bronchitis or congestion of the lungs to which the child may be liable, besides rendering these more frequent. The legs bend under the weight of the body, and become "bowed," the thighs being too short in proportion to the forelegs. From this curvature, the baby is able to put his toes into his mouth, a feat that greatly delights the nurse and mother, but should rather awaken their solicitude. Finally, the pelvis remains too narrow, a matter of small moment with boys, but which in girls entails the prospect of serious dangers in future years, when they in their turn shall be called upon to be mothers, and to encounter all the pains and perils of childbirth. Rickets, with all its formidable consequences, has been, in modern times, often ascribed to artificial feeding. But this supposition, like the old theory that regarded rickets in children as a special punishment of vicious luxury in parents, seems to have been made very much under the influence of moral considerations. Closer observation has shown that rickets is much more prevalent among the poor, who habitually bring up the children at the mother's breast, than among the rich, where the frequent failure of mother's milk, and dislike of a wet-nurse, often necessitate artificial food. With a better understanding of the immediate causes of rickets, it is easy to see that the same conditions which induce the disease when the child is brought up on the bottle, may exist when it is most strictly limited to the mother's milk. These causes are: 1st. Deficiency of phosphates in the food to supply the place of those consumed in the organism. 2d. Excessive formation of acids in the digestive tube, which, being absorbed into the blood, dissolve out the phosphates already fixed in the body, especially in the bones, and carry them off in the urine. Now, farinaceous food is very deficient in phosphates, and hence, when substituted altogether or in part for milk in a baby's diet, is indeed often a cause of rickets. But the milk of anemic or of ill-fed women is also deficient in phosphates, and very often in all the solids proper to healthy milk. It may induce rickets therefore quite as surely as artificial food. It not unfrequently happens when two children have been born near together, that the first will be healthy, but the second delicate, with imperfect digestion, or with some marked disorder of nutrition, as manifested in the so-called scrofulous diseases, or in rickets. The mother's blood has been rendered anemic during her first pregnancy, that is, it has lost a certain amount of its albumen and of its red corpuscles, because the materials usually employed in their renewal have been diverted to the nourishment of the child. If she become pregnant again before she has recovered from this anemia, her blood is not in a condition to furnish materials for the secretion of normal milk This is therefore watery, or poor in phosphates, or even deficient in all the solid ingredients, as in the milk of women rendered anemic by other causes, and the child fed upon it will become rickety.

The substitution of cow's milk for breast milk could never be injurious by deficiency of phosphates, for it contains more than double the amount proper to human milk. But cow's milk, as will be shown in another place, is often difficult of digestion on account of the excess of butter, and of the abundance and the peculiar nature of its caseine. The butter and cheese, imperfectly digested, ferment and give rise to acids, which pass into the blood and dissolve out the phosphates, in the manner already described. The action of cow's milk, therefore, when it is injurious, belongs to the second class of causes capable of producing rickets. There are many other things that have the same effect upon the digestion, and hence are indirectly capable of inducing this disease. The farinaceous food, that is already rendered unsuitable by its poverty of phosphates, is particularly liable to acid fermentation, for its starch is first changed into dextrine, then sugar, finally lactic acid. Meat, prematurely introduced into the diet of young children, will remain undigested, and give rise to the same acids as form with a surplus of caseine from undigested cow's milk. So the means so frequently taken to make weakly children strong, often results in making strong children pine away. Absence of fresh air is, among the poor, so generally associated with other conditions known to produce rickets, that it is difficult to fix precisely its degree of influence. But it has been ascertained by careful comparison be tween different localities, where children brought up on the same food are exposed to fresh and pure or to close and ill-ventilated air, that the latter will alone be sufficient to derange the digestion, induce acid fermentation, solution of bony phosphates, and rickets. The influence is more indirect than that of indigestible food. Respiration of badly oxygenized or impure air alters the composition of the blood: the red blood corpuscles carry less oxygen, and the impoverished blood stimulates the nervous system insufficiently. There is less nerve force sent to the stomach, and hence the gastric juice is not formed in sufficient quantity to digest the food; and again the undigested part ferments, acids are formed and absorbed with the usual consequences. Finally, as the mother's milk may be injurious by a deficiency of phosphates, so it may also act like this second class of causes by the presence of acid. Milk should be feebly alkaline; and it is pretty well known that hot weather hurts cow's milk that has been standing, by favoring the change of sugar into lactic acid, which, when in great excess, curdles the milk. In rheumatic women, whose blood contains this acid, the milk is liable also to be acidified. From this cause the baby will pine, to the great astonishment of the mother who boasts of the abundance of her milk.

The mechanism of these various digestive arrangements will be explained in a little more detail in another place. They are mentioned here to show the futility of the idea that maternal milk is a necessary preservative against this disease, and that artificial food is the only cause of its occurrence. We see, on the contrary, that it is possible for natural food to become as abnormal as artificial food, and to induce precisely the same disturbance in the processes of digestion and nutrition. And when artificial food disagrees with the baby, it does so, in the great majority of cases, on account of definite chemical or physical alterations, that can be easily ascertained and remedied. There are, indeed, other and more subtle properties, that may render unfit for use milk which to all tests but that of the baby's stomach seems perfectly normal; or, on the other hand, may impart unexpected nutritive value to milk that does not to our tests differ sensibly from that which has been rejected. These purely animal properties depend upon the constitution of the woman furnishing the milk, and the alterations or diseases of her constitution may be defined, even when the alteration in the milk cannot be. We have already spoken of the milk of lymphatic women, or of those laboring under constitutional diseases, as consumption, epilepsy, skin affections, etc. We have shown, however, that even in these cases a definite chemical alteration of the milk generally exists, sufficient to explain the injurious effect observed upon the nursling. So that the cases are largely in the minority where we must ascribe this effect to a "vital agency," otherwise inexplicable. But if we do not explain the ill effects of poor milk by a "perversion of its vitality," we have no right to explain the nutritive effects of good milk by the existence of such vitality. Or, in other words, we have no right to say that the milk of the mother nourishes the child in virtue of any mysterious inimitable life-giving power, but on account of a definite chemical composition, that may, with sufficient care, be accurately imitated.

Before attempting to describe the manner in which the baby's natural food may be most successfully imitated, it may be well to say a few words in regard to the manner in which breast milk may be kept in a normal condition, or a healthy composition be restored when this has once been lost. We may then, further, enter upon some details in regard to the processes of infant digestion. When these are already understood and kept in mind, it is much easier to appreciate the modifications that may be induced in them by the different modifications in diet. Whether we consider breast milk, cow's milk, or prepared food, the problem is essentially the same. If the milk is to be obtained from the blood of the mother, we must take care that the right materials in sufficient quantity get into her blood, just as we must put the right materials together into a retort if we wish to get out of the retort a product of definite chemical composition. This proposition is elementary in its simplicity, yet it is constantly forgotten, or obscured by the most fantastic theories. The diet of a nursing mother, as the *régime* of a pregnant women, offers a field over which popular prejudices may ride headlong. Many rules are adopted in obedience to some superficial analogy, that a better understanding of the subject would show to be superfluous or absurd. Thus nursing women are often forbidden to eat acids, or acid fruits, lest the milk should turn sour. This theory of resemblances is a "survival" from an entire system of philosophy once very prevalent, according to which turmeric-root was said to cure jaundice because it was yellow, the red sanguinaria was called blood-root, and supposed to make blood, and so on. The truth is that vegetable acids, as soon as they are taken up into the blood, are converted into carbonic acid, which combines with soda and potassa to form alkaline carbonates. Long before they could reach the milk glands, therefore, their acidity is destroyed. Further, when fruits are carefully excluded from the diet, the bowels are very apt to become constipated: their contents, retained too long, ferment, and give rise to many so-called fatty acids, which *do* pass into the blood, and out of it again in the breath, the secretions of the skin, the milk. By them the breath may be rendered foul, the skin greasy, and the milk really sour, and become a cause of colic and indigestion to the baby

Every kind of diet that is known to cause constipation must therefore be scrupulously avoided by a nursing woman, while fruits, on the other hand, are extremely desirable as articles of food for her. In hot weather, when perspiration is abundant, it has been said that the proportion of water in the milk diminishes, and the milk becomes indigestible because too concentrated. It is then necessary to take cooling drinks, abundance of water, to replace that evaporating from the skin, vegetable acids, or citrate of potassa, or even mineral acids, diluted into lemonade. Citric acid (found in lemon-juice) is changed into carbonic acid by taking up oxygen from the blood. Less oxygen is left therefore to oxidize or burn the tissues, and less heat is produced. Mineral acids, as the aromatic sulphuric, act in a different way. They are astringent, contract the blood-vessels of the skin, and thus diminish the amount of blood circulating on the surface, and the amount of water that can be transuded through the walls of the vessels, in perspiration. They diminish heat, by antagonizing the combustions going on in the blood, although they are not oxidized, but form salts with alkalies, and thus pass off in the urine.

It has been said that rheumatic women, whose perspiration is acid, probably contain lactic acid in the blood, that is, often sufficient to acidify the milk and even become a cause of rickets. It is very customary to give large doses of alkalies in the treatment of rheumatism; and the use of alkaline waters, as Vichy, is certainly indicated for rheumatic patients who desire to nurse. Where, however, rheumatic tendencies are strong or inveterate in the mother, it is better that the child have a wet-nurse. All anemic women, and all women in whom two or more pregnancies have succeeded each other very rapidly, should take small doses of phosphates, especially the phosphate of lime, combined with phosphate of iron and with carbonate of lime. In many cases it is useful to begin such treatment, or rather such necessary food, during the pregnancy, and continue it throughout the period of lactation.

An idea has obtained popularity in some quarters that pregnant women should avoid the use of mineral salts, and especially of lime, in order to "keep the bones of the child soft, and secure an easier labor." As the bones of a newborn child are always "soft," i. e. very imperfectly ossified, this precaution is superfluous, and indeed highly fantastic. The rigid exclusion of salts from the diet of a pregnant woman would seriously interfere with the general nutrition of her body, and of that of the child, but the condition of the bones would be, relatively, little modified. The dangers to the mother from the excessive size of the child, are to be averted by maintaining a due proportion between the whole amount of food and the amount of exercise taken.

An idle and too sedentary life, in which neither the muscles nor the nerves of the mother make any demand upon the nutrition, while the consumption of nutritive material is increased, permits this to be too largely diverted to the child, whose growth then resembles that of a parasite, and is out of all proportion to the body of the mother, to which it should be adjusted.

Deficiency of butter or of caseine in the mother's milk is to be remedied, when possible, by nourishing diet to the mother. It is important to remember that the same food may be nourishing or not, according to the capacity for digestion, and that, whenever it is considered desirable to introduce more food into the body, it is necessary to provide at the same time for increasing the digestive capacity. This is why we must insist upon exercise, which is often recommended in general terms to nursing women, without any reason being given for the precept. Muscular exercise increases the respiration, or the rapidity with which substances are oxidized in the blood and eliminated from it by the lungs and kidneys. Hence is increased the rapidity of the demand for new material to be thrown into the blood; and the sensation of hunger, which interprets this demand, is more intense, and more often renewed, the appetite is awakened, and the stomach will bear more food. Other effects of muscular exercise are important, but for our purpose this is the principal—that it accelerates the processes of nutrition and denutrition, and hence makes room for more material to be taken up into the system, and utilized not only in the formation of solid tissues, but of such liquid tissues as the milk.

The same result is obtained by agencies which quicken the circulation in the skin and muscles, and, increasing their nutrition, increase the demand for the materials of nutrition. The supply that will be thrown into the blood will be sufficiently in excess of the demand to provide for an increase also in the secretion of milk, even in persons in whom the nutritive demand created by this secretion seems insufficient to increase the appetite. Cold bathing, and systematic rubbing and kneading of the limbs and surface of the body, are powerful means of securing this end.

The degree of excess in the quantity of food required by a nursing woman is very variable; as a rule, however, such excess is much more generally required than during pregnancy. Here a spontaneous provision exists for the surplus material required for the development of the child, in the mechanical difficulties that render muscular exercise difficult, and thus diminish the demand for food on the part of the mother. If, therefore, she continue her ordinary scale of diet, she will, other things being equal, still have enough both for herself and the child. But during lactation, her capacity for physical activity returns, or should return, and she is then compelled to sustain an extra function of nutrition, while all the ordinary demands for nutrition continue in full force. We think it is because the necessity for extra diet is insufficiently appreciated, and met by inadequate provision, or by overfeeding without means to increase the digestive power, that the nutrition of so many women becomes more seriously impaired by nursing than by pregnancy, and that their supply of milk is so soon exhausted.

As these remarks on the diet of nursing are merely incidental to our subject, and not intended to be exhaustive, we will omit a detailed consideration of the articles of food that are the most nourishing, that is, that will best tend to secure in the milk a normal proportion of caseine and butter. Only one or two points of special interest may be touched upon. Similar to the popular prejudice that would exclude fruits from the diet of a mother, is that which insists on a preponderance of meat. Like all popular ideas, this is the ghost of a theory that was once held as scientific, when albuminous substances were considered to be the principal articles of diet—those preëminently required to repair the wear and tear of the body; and that to these the hydrocarbons, the sugars, starches, and fats, were merely accessory, and to be burned as fuel to maintain the heat of the body. It was found, however, by experiment, that pure albumen was entirely insufficient to sustain life, and that dogs fed on it died of inanition. Then it was found that the combustion of albuminous substances contributed to the heat of the body, though in a less degree than that of the hydrocarbons. Quite recently, the production of heat has assumed a new importance, from the discovery of its relations to motor force. It was found that every movement which took place in the living body required a certain amount of heat—that the contraction of a muscle was as dependent on heat as was the movement of a piston in a steam-engine. This astonishing discovery has quite changed the aspect of the functions of different kinds of food, and given to the hydrocarbons a value in some respects higher than that of albuminous substances, though these are represented by meat, which most resembles the tissues of the human body. These, therefore, replace those tissues when they are destroyed, as iron and brass repair the waste in the material of which a locomotive is made. But as the locomotive requires coal in order to be set in motion, and as the need for the consumption of coal during its period of activity is much greater than the need of repair, so the human body, at any moment, requires a much larger proportion of food that shall furnish heat, than it does of food which may be directly assimilated to its tissues.*

The only circumstances calling for a very large proportion of nitrogenous food, i. e. meat, are those that

* Comparison quoted by Schiff from the memoir of Fisk and Wislicenus.

involve great activity of the nervous system. All others, and perhaps especially the nutrition of nursing women, require a large proportion of other food, and no advantage is gained by insisting on a meat diet as more nourishing. The normal proportion between nitrogenous and non-nitrogenous food is about as one to four, and this proportion need not be varied for nurses. The excess of food required is better made with oatmeal, Indian-meal gruel, bread, chocolate, etc., than with an extra allowance of meat.

There is no indication for stimulants in order to increase the quantity or the richness of the milk, although they may sometimes be needed to support the nursing mother. We have already described those cases where intense pain is produced in the chest by the act of nursing, and where, in the absence of any soreness about the nipples or inflammation of the breast, the pain must be attributed to neuralgia of weakened nerves, when these are excited to enable the gland to secrete milk. Such pain may often be averted by a glass of wine or ale, taken just before giving the child the breast. Alcoholic stimulants are needed wherever the woman has become debilitated by nursing, and where the secretion of milk threatens to be suspended from this cause, they may indirectly increase it. But not otherwise.

In regard to a deficiency of sugar, or to an excess of salts in the milk, no remedial measures of diet can at present be prescribed. Remedies are usually addressed rather to other conditions of the milk which may accompany these, as to the excess of caseine found with deficiency of sugar, or to the excess of water, with excess of salts, especially the chloride of sodium. It has been already said that sugar may be added to the milk which nourishes a child at the breast, as easily as to that which he would take from the bottle, by the simple expedient of giving it to the child in water immediately before the breast. In the same manner the excess of caseine is remedied.

Instead of the sugar-water mentioned above, we may give the baby each time before it is put to the breast a table-spoonful or more, according to age, of strained and well-sweetened oatmeal gruel, for reasons, and prepared in a manner to be designated hereafter. Thus sugar is added, the milk is diluted in the stomach by the decoction of oatmeal, the caseine is brought into a slow contact only with the gastric juice, and is better prepared for being dissolved again for digestion, and less apt to stimulate the gastric glands into undue action. For this plan, also, which has been serviceable in many cases where the former simple one would not suffice, I claim good theoretical reasons, and the results of a various, and, I believe, unbiassed observation of a long number of years.

It would certainly often be desirable, were it possible, to modify the mother's milk in other ways than those above specified, and especially to impress upon it those subtle animal characters to which we have referred as eluding chemical analysis, yet becoming the means of confirming constitutional peculiarities, or of transmitting constitutional diseases. But for this purpose, the physical education of the mother must precede by many years the moment in which she assumes the function of lactation, and must, to facilitate the accomplishment of this function, secure adequate development for all other bodily functions. In this generality the subject escapes our present grasp. We turn to another—from the mother to the baby—from the consideration of his primitive natural food, to that of the methods by which he is enabled to appropriate it to his use. It is only when the process of infantile digestion is clearly understood, that reasoning about infants' food becomes intelligible.

It is understood that food, in its passage through the alimentary canal, undergoes a series of chemical changes, by which it is rendered fit for absorption into the blood and assimilation by the tissues. These changes are effected by the fluids secreted at different parts of the canal, and which act differently upon the various elements of which the food is composed. The first digestive fluid is the saliva, which is poured out by three pairs of glands that surround the cavity of the mouth, and becomes intimately mixed with the food at the first moment of its ingestion. The influence of the saliva is, however, limited to one substance, starch, which is converted by it into sugar, and thus rendered soluble. It is remarkable that this change, the first which takes place in the food of human beings, is likewise the first step in the digestion of plants. During the winter, an immense amount of starch remains stored up in the roots—sometimes, as in the potato, constituting the entire edible part of the plant. Concealed with the starch is a minute quantity of a peculiar albuminous substance called a ferment, which in the spring begins to act upon the insoluble starch and convert it into soluble sugar, that may rise in the sap and be carried to all parts of the stem to feed the growing buds. A similar ferment exists in human saliva, and though in very minute quantity (for ninety-nine parts out of one hundred of saliva are water), suffices to convert the starch of farinaceous food into sugar, which passes into animal blood-vessels, and is carried to remote cells where starch could never penetrate.

Now, in relation to infant diet, the most interesting point about starch is the fact that the typical food, milk, does not contain any. This fact is already a warning that farinaceous food is probably unsuited to young babies, for such food principally consists of starch, and is therefore as foreign to nature as we could well make it. It is, indeed, the only elementary food that is not represented in milk. Instead of starch, that must become grape sugar before it can be absorbed, we find milk sugar already formed; and, corresponding with this peculiarity, we find that in young babies the apparatus for changing starch into sugar, the group of salivary glands, is very incompletely developed. There are, as we have said, three pairs of salivary glands: the parotids, which on each side extend from the ear to the angle of the jaw, and which become inflamed in "mumps;" the submaxillary, which are under the chin; finally, the sublingual, smallest of all, and which, as the name implies, lie on the floor of the mouth under the tongue.

These glands begin to develop as early as the second month of fœtal life, and about the end of the third are well marked. But they are small at birth; the parotid glands which, combined, weigh at fifteen months 80 grains, and 120 at two years, weigh but 34 at the age of a month.

In adult life, moreover, the function of the glands is much influenced by certain nerves, as some branches of the facial nerve,* or the nerve distributed to the tongue. When these nerves are irritated, a considerable flow of thin limpid saliva takes place. But in young babies, irritation of these nerves has very little effect. Not only the salivary glands are imperfectly developed, but the parts of the brain to which these nerves run are unaccustomed to respond to irritation.

* Chorda tympani.

Besides the salivary glands of the mouth, there is a laıge gland in the abdomen whose secretion has the power of turning starch into sugar. We have already mentioned it as the pancreas, and described its situation behind the stomach, and alluded to its popular name, in edible animals, as the "sweetbread." We have referred also to one important action of the pancreatic juice—that it emulsifies fats and prepares them for absorption; and decomposing fats into the fatty acids and the glycerine of which they are composed, enables the latter to combine with phosphoric acid, and be carried to the bones to form the solid phosphate of lime. In order to compare the action of the pancreas upon starch with that of the parotid, Dr. Korowin, of St. Petersburg, has made some interesting experiments. (Central Blatt, 1873.)

He made infusions of the pancreatic glands and of the parotids, by steeping them in water so as to extract their juices, and then adding these to solutions of starch. It was thought possible that, although the salivary glands of the mouth were incapable of digesting starch readily during the first months of the infant's life, the pancreas, which has been called "the salivary gland of the abdomen," might be able to supply their deficiency. But the experiments showed, on the contrary, that the pancreas acquired its starch-making power even later than the parotid glands. According to Korowin, the infusions of the pancreas taken from infancy in the first month of life, exhibit no power to change starch into sugar. The first traces of this fermentative effect become perceptible in the course of the second month only, but it increases so rapidly in the third month as to permit of a quantitative analysis of the new-formed sugar being made. It then increases gradually until the end of the first year, when it is developed to its full extent.

Infusions of the parotid gland, however, have the effect of transforming boiled starch into sugar in the very first days of life. The quantity of newly-formed sugar is so great as to be measurable. The fermentative effect of the parotid gland corresponds with the size of the child.

Korowin has besides experimented upon the saliva of infants. To obtain it, he introduced pieces of fine sponge into the infants' mouths. After they had sucked awhile, he withdrew the sponge. Some saliva was thus collected within a few minutes after birth; but great patience and pertinacity were required in gathering it for the period of two or four weeks. Tenfold the time was required at this age as in infants of three months. A single cubic centimer required from fifteen to thirty minutes. In some cases none whatever was obtained, although there had been some secretion before. The amount of saliva increased considerably about the end of the first month; in the fourth month a cubic centimeter or more was obtained in from five to seven minutes. This is the period when the increased salivation is perceptible to every one. Korowin collected saliva from seventeen infants, at the age of from one to ten days. It transformed starch into sugar. This fermentative effect of saliva increased with age up to the eleventh month. As a number of infants remained under observation during a period of several months, the experimenter had ample opportunities to verify this fact. His observations are numerous, his quantitative analyses alone amounting to one hundred and twenty. Finally, he compared the diastasic (i. e. sugar-making) effect of the saliva of an infant of eleven months with his own, and found equal results from equal quantities.

Thus, from what we know at the present time about infant saliva, we conclude that a small amount of starchy food can be made available as a nutriment even before an infant is three months old. Additions to milk need not be entirely free of starch; but as the amount of saliva may differ in individuals, at various times and from various nervous and mechanical influences, it is safer to select from the list of farinaceous or amylaceous articles such as contain albuminous matter and salts in preponderance.

There is probably no rule for infant diet of more importance than that which regulates the amount of starch which may be given to the child; for errors on this point are extremely frequent, and have most serious consequences. It is the general belief of mothers and nurses that thick food is more nutritious than thin, and hence, almost as a matter of course, they mix corn-starch, arrow-root, farina, bread-crumbs, etc., in the milk of the youngest child with whose natural food there is any pretext for interference. Now, it would be nearly as rational to thicken the milk with sand. In reality, other things being equal, the thinner food is, the more nourishing it is, for the very simple reason that it is more readily absorbed. We will refer to this important fact again, in speaking of digestion in the stomach. And in the second place, as shown by the above-mentioned experiments on the salivary glands, since so small provision exists in the young child for changing starch into sugar, when any abundance of starchy food is given, the larger part remains unchanged, insoluble, indigestible, and undigested. Any substance that stays in the stomach or bowels without being dissolved, is liable to cause irritation and pain, and many fits of screaming and colic result from nothing else. But the remote effects of this innocent-looking farina are even more disastrous. A fermentation is set up of a different nature from that determined by the special ferment of the saliva, instead of sugar, lactic acid is formed in excess, passes into the blood, and dissolves out the earthy phosphates from the tissues, in the way that has been already described. Hence an arrest of nutrition, softened bones, general rickets. It is because children brought up on the bottle are so frequently crammed with farinaceous food, and become rickety from this cause, that so many writers have ascribed rickets to the mere absence of breast milk.

On account of the great prevalence of this error in diet, and the insidious manner in which it may induce disease, intelligent mothers should be prepared to detect in their babies early signs of disordered nutrition, so that medical skill may be invoked before it is too late. The most important early signs that may be recognized by the non-medical observer are the following:

Green passages, with alternations of constipation and diarrhœa.

Profuse sweating about the head.

Tendency to hang the head backward.

Slight swelling of the wrists and ankles.

Slight curvature of the leg below the knee.

Dentition retarded beyond the tenth month.

Very large fontanelle after the sixth month.

The green color of the passages is not due to an excess of bile, but to the acid which colors the bile that should be present. The acidity of the passages is easily demonstrated by laying a piece of blue litmus paper on the napkin. It will immediately turn red.

Sweating of the head is of no importance if only observed when the child has been overheated, has been sleeping in a warm bed, etc. The rachitical sweating will appear even when the child has been kept cool.

The fontanelle, or opening in the top of the head, gradually increases in absolute size until the sixth month, because the growth of the head is more rapid than the process of ossification by which the fontanelle should be closed. But from the age of six months, it should grow constantly smaller, and by fifteen months should be entirely closed.

The peculiar soft white flesh so characteristic of rachitical (rickety) children is usually a matter of pride with the mother, who boasts of the beautiful complexion of her baby. It is perhaps scarcely possible for her to distinguish the fairness that indicates disease, from that which may be legitimately admired ; and hence this sign is not given among those that she may look for to test the health of her child.

The deformities that result from an advanced degree of rickets, the pigeon breasts and crooked legs, are so well marked that no ordinarily careful mother would overlook them. She is only likely to attribute them to an accident, a fall, to the carelessness of a servant. The absurdity of this idea is made evident by the details that precede, as also the injustice that attempts to shift the responsibility of misfortune.

After leaving the mouth, the baby's food descends by the œsophagus to the second reservoir provided for its reception, the stomach. To the popular view this is altogether the most important part of the alimentary canal, and almost the exclusive organ of digestion. Now, in adult human beings, this view is extremely incorrect, for the effect upon food of the saliva, and of the process of mastication, is already important, before the stomach is reached, and a large proportion of the food leaves the stomach undigested, and is only completely prepared for absorption in the intestine. But in babies, the relative importance of the stomach is much greater. There is no mastication, and, as we have seen, little saliva; and of the typical food, milk, a much larger proportion than of any other is completely digested in the stomach, leaving a much smaller residue to be transmitted to the intestine.

The nature of infants' food is so different from that of adults, that the process of digestion is also in many respects necessarily different. The shape and position of the stomach is already different. It is situated of course in the same place, that is, behind that part of the abdominal wall called the epigastrium, and which constitutes the triangular space below the breast bone, and between the ribs that diverge on each side from their attachment to this bone. In the adult, the stomach lies transversely; but in the baby, the liver is so large as to stretch entirely across the epigastrium to the left side, and the stomach is pushed back, so that it lies obliquely from left to right. Again, in the adult, the stomach is much dilated at its left extremity, that into which the œsophagus opens, and into which the food first falls. From this end, called the cardiac on account of its proximity to the heart, the stomach tapers towards the other end, that is very much smaller, in fact, only just the diameter of the small intestine with which it is continuous, or which may be said to be fitted on to it as a tube may be fitted to the beak of a retort. A cone is thus formed, with the base at the left and the apex at the right, and curved upwards and backwards. On account of this curve, the lower border of the cone is long and convex, the upper border short and concave.

The form of the stomach, and its size as compared with that of the other parts of the digestive canal, vary much in different animals. There is a primitive type that seems to represent the simplest and most abstract conception of a digestive apparatus, that is, a straight tube, with a mouth at one extremity and an anus at the other, and receiving here and there the secretions from a few glands, scattered along its course. This is the appearance of the alimentary canal in the embryos of all vertebrated animals, and in some fishes. It becomes more complicated when the organism to be nourished is more complex, and requires more complex food, and more elaborate digestive processes. First, the straight tube grows longer, and must be folded up in order to fit into the body. Then it dilates at certain parts of its course: the pharynx is first formed, then the stomach, then the intestine becomes divided into a small and large portion, then certain parts of the latter are specially enlarged, as the cæcum and rectum. The glands that open into the tube also grow, and the digestive apparatus and the abdomen thus acquire an immense size relatively to the rest of the body. This is especially noticeable in herbivorous animals, in whom the digestion is the most absorbing function, and continues almost as uninterruptedly as breathing or circulation. Among birds and ruminating animals, there are several stomachs, each with a distinct office, and the process of regurgitation and remastication of food gives to the mouth and its secretions an importance in digestion that does not exist anywhere else. Among carnivorous animals, the digestive apparatus is more compact. There is only one stomach, that concentrates in itself the apparatus and the functions that in other animals are distributed among several organs. The action of the saliva is only begun in the mouth, and not completed until after a long sojourn of the food in the stomach. The stomach is divided into two parts, one secreting the gastric juice that shall transform the food; the other providing for the absorption of materials that do not require such transformation. This double action is further effected by a double arrangement for the circulation. Part of the blood-vessels run vertically, surrounding the glands that are plunged in the thickness of the mucous membrane; and another part runs horizontally to the surface of the membrane. The first furnish material from the blood for the secretion of the glands, the second absorb soluble material from the cavity of the stomach into the blood.

Now, the peculiarities by which the stomach of the human infant differs from that of the adult, either correspond to an inferior stage of animal development, or are exaggerations of those by which the stomach of the carnivorous animals differs from that of the herbivoræ. We have said that its situation was more oblique—it is, indeed, nearly vertical—and as the large (cardiac) end is very much less developed, the entire organ is narrower than in the adult, and therefore offers a slighter deviation from the straight vertical tube that constitutes the primitive type of digestive canal. Its shape, therefore, re sembles that of the dog. The cardiac half of the stomach is that which contains the gastric glands for the secretion of pepsine, and its smaller size in babies implies that in them there is less pepsine secreted for the digestion of albuminous substances.

Nevertheless, as we have said, of the food which is adapted to this imperfect stomach, a much larger proportion is digested in it, and that more rapidly, than is the case with adults. With them the stomach is not entirely emptied of food under four or five hours after a meal; but in babies the digestion is over in little more than an hour, and within two hours the stomach is ready for more. In this rapidity of action, the baby's stomach resembles that of the carnivorous animals, and is more widely removed from the herbivorous, in whom digestion is going on nearly all the time. In some of the herbivoræ—as the rabbit—the stomach is never empty. On the other hand, the frequency with which the repast must be renewed for the infant, obliges him to spend a much larger part of the day in eating, so that he resembles the herbivoræ in the disposition of his time—although exaggerating the type of the carnivoræ in the action of his stomach.

The facility with which a baby vomits is another point of resemblance with the latter class of animals, and of difference from the herbivoræ, who vomit with much greater difficulty, or even not at all. "The stomach of the dog," observes Schiff, "does not enter into the long discussions with indigestible food to which the human stomach is habituated, but rejects it promptly and completely, and, once relieved, returns to its functions again without delay or *malaise*." It is the same with babies, in whom vomiting is so frequent that it is often regarded by mothers and nurses as a sign of health. Its facility has been explained by the vertical position of the stomach, and the small development of its cardiac extremity, so that the cavity continues in nearly a straight line with the œsophagus. (Schultz.) These circumstances may show why the contents of the stomach can pass more easily out of the orifice by which they have entered, but they do not explain the impulse that sets them in motion. This is given, in the child as in the adult, by the layers of muscles surrounding the stomach, and which are compressed when the stomach is distended. These muscular layers consist of the abdominal walls in front, and, above and at the side, of the diaphragm, a great horizontal muscle that forms the floor of the chest, and shuts in the lungs from the abdominal cavity. In the adult, the cardiac extremity of the stomach is capacious, and sinks back into the abdomen as it becomes filled with food. Only when the accumulation of food is excessive is the anterior wall of the stomach distended, and then the lower border rises and presses against the abdominal walls. From the small size of the cardia in babies, this point of distension is much sooner reached, the long narrow stomach rolls upwards, and, compressing the abdominal muscles, is in turn compressed by them. At the same time the stomach is pressed by the large liver against the diaphragm, so that the latter has less space into which to descend when the lungs expand during inspiration. If, therefore, the baby takes a longer breath than usual, and the diaphragm is pushed down a little farther, it also compresses the stomach, which thus is squeezed on nearly all sides. (Allix.) At the beginning of digestion, when the stomach is most distended and the pressure from without the greatest, the pyloric orifice, or the opening into the intestine, is closed. It only opens gradually, and in proportion to the amount of food that has become thoroughly prepared for entrance to the intestine. Since this proportion is always smaller with babies than with adults fed upon solid food, the pylorus habitually opens with more difficulty, or, rather, it has not yet became habituated to open with ease. The door of entrance to the stomach, on the other hand, or the cardiac orifice, is opened by muscular fibres which from birth are ready to respond to irritation : the whole force of the pressure, therefore, to which the stomach is submitted, bears in the direction of the least resistance, upon this orifice, and the milk is squeezed out of the stomach into the œsophagus, its exit being facilitated, as already said, by the nearly straight line in which this canal continues with its own cavity.

From this disposition, the baby's stomach, like that of the dog, is able to avoid "long discussions" with food indigestible either from quality or quantity, and to relieve itself promptly, where indecision would be most disastrous.

But there are many kinds of vomiting, with varying degrees of importance, as will be shown later when we speak of the details of digestion.

The fact that the baby's stomach resembles that of carnivorous animals so much more than that of herbivoræ should already discredit the notion prevalent among some people, that vegetable food is more "natural," hence more "innocent," hence more suited to children than animal food. Really fierce denunciations appear from time to time in popular treatises on hygiene, against the "fatal practice" of making "an innocent child a flesh-eater." The moral impulse to this prejudice, that claims to be so enlightened, is a curious instance of "survival" of the old savage idea that persons acquired the characteristics of the animals upon which they fed.* Practically, and as a means of preventing the premature introduction of solid food into the diet of the young child, the prejudice may be useful; but the theory upon which it is based is absurd, inasmuch as the milk, unquestionably destined for babes, is a purely animal food, and desirable precisely on account of the facility with which it may be assimilated to animal tissues.

The peculiarities in this typical food all correspond to peculiarities in the digestive apparatus of young children. We have already insisted on the absence of starch, which is necessitated by the imperfect action of the salivary glands. The liquid form of the food is as evidently necessitated by the absence of means of mastication. It would be equally correct, however, to say that the teeth are absent because rendered superfluous by the liquid form of the food, and because they would, by injuring

* See Lubbock, "Origin of Civilization," p. 12.

the nipple, impede the process by which the food is obtained. This special form of food, therefore, must be imposed by more general conditions than those of the mouth. It is common to the young of only one class of vertebrated animals—the mammifers. Birds have no teeth, but from the time they emerge from the egg they are fed upon solid food—even those species which are at first too feeble to feed themselves. In birds, however, as is well known, the trituration of food is effected in the gizzard, and hence requires no voluntary muscular exertion such as that involved in mastication. For this exertion the young of mammifers, and especially the human young, are too feeble, and this is the first reason why they are provided with food that does not require it. Those animals which, like calves and colts, rapidly acquire muscular force enough to run about, begin to browse long before they have given up nursing, and the maternal milk is continued as a luxury long after it has ceased to be the exclusive article of food. But kittens and puppies lie huddled in blind impotence for many days: their muscular feebleness approaches that of the human baby, and, like the latter, they remain till a much more advanced age entirely dependent upon milk. The muscular strength seems therefore itself to be proportioned to the deeree to which the animal can digest other substances than those contained in milk. In herbivorous animals destined later to feed upon starchy substances, the greater development of the pancreas and of the salivary glands, and in ruminants the four stomachs, enables starch to be digested much earlier than is possible in animals possessed of a single stomach and little saliva, as kittens, puppies, and human babies—in a word, of animals who in adult life will feed partially or altogether upon flesh. Hence the calf can feed upon grass, that contains starch; but the kitten needs from the beginning a food that shall represent flesh, and requires a concentrated and compact digestive apparatus, and milk is the only food which fulfils these conditions. As in all physiological series, therefore, it is difficult to say which is the starting-point. We can hardly ever affirm that any one condition exists in order that another may exist: we can only say that a number, mutually dependent, coexist. The baby's food is liquid because it has no teeth, and it has no teeth because it is not strong enough to masticate, and its strength increases more slowly than that of all other animals because its scale of development is everywhere larger and the rate slower, and on this account must it be longer dependent upon the mother for food; and in all other mammifers similarly situated in the above respects, milk is the only liquid food procurable by the mother. The only mother who might exercise a choice in this respect, the human mother, is forbidden to do so because the others cannot, and because the organization of her baby has been submitted to the laws which govern that of their young.

Upon following the milk into the stomach, we shall find other reasons for its liquid form, and for the absence of starch, than those which have been mentioned. Water, contained in all substances, is of course in much larger proportion in liquids than in others. In milk, about eighty-eight parts in every one hundred are water. The water facilitates the digestion of the albuminous substance, the caseine. In experiments upon digestion of albumen with gastric juice obtained from the stomach of animals, it was noticed that after a certain time the process began to slacken, but was renewed merely by the addition of water. The gastric juice became saturated with the substances it had dissolved, and ceased to act upon what remained until it had been diluted. In the living stomach this dilution is of even greater importance, for it permits of the immediate absorption of the substances soluble in water, and which do not require the specific action of the gastric juice. The elements of the milk thus rapidly taken up into the blood with its water are the sugar and salts: the butter passes into the intestine, and the caseine alone is submitted to the action of the gastric juice.

The gastric juice is made up of three things, water, hydrochloric acid, and an albuminous substance called pepsine. This pepsine, when associated with acid (but not otherwise), attacks albuminous substances in such a way that they become disintegrated, and finally transformed into a soluble substance called peptone, and an insoluble residue called parapeptone.

The pepsine is formed in glands situated in the cardiac half of the stomach (relatively small in babies). These glands are straight tubes, standing side by side in the thickness of the mucous membrane, with an open extremity turned towards its surface, and a closed end plunged in its depth. Each tube is filled with large irregularly shaped cells, and these secrete the pepsine. The material for the secretion is furnished by a network of blood-vessels, which, as has been said, enlace each peptic tube. The amount of pepsine that may be formed depends very much upon the substance circulating in the blood of these blood-vessels. By injecting into the veins of an animal solutions of certain substances, as sugar, digested meat, or especially dextrine, a substance intermediate between starch and sugar, it is possible to greatly increase the amount of pepsine contained in the stomach glands. The same thing will happen when the injection is made into the rectum, whence it is absorbed into the blood. Finally, in ordinary circumstances, the material for the formation of pepsine is derived from the substances soluble in water which are absorbed from the stomach at the beginning of the digestive process, pass into the blood, and set the glands to work. This fact justifies the habit of eating soup before meat. The soluble materials of the soup pass into the blood, and the blood-vessels surrounding the glands, and start their secretion, so that by the time the meat arrives there is a sufficient proportion of pepsine ready to digest it. In older children and in adults the water of the saliva prepares a solution of many substances which are not acted on by the peculiar ferment of this secretion. The absence of saliva in babies is therefore another condition that necessitates a large amount of water in their food. So long as the food remains in the stomach, whatever is digested and absorbed contributes to the secretion of new quantities of pepsine, so that more is manufactured as fast as needed. But when the transformation of the food has reached a certain stage, the pylorus opens, and the liquefied mass begins to flow into the intestine. The absorption from the intestine no longer furnishes material for the secretion of pepsine, and hence, as the food passes out of the stomach, the pepsine gradually ceases to be formed, what has already been secreted is consumed, and finally, at the end of digestion, i. e. four or five hours after a solid meal, the stomach is completely deprived of it.

In milk babies may be said to eat their soup and meat together, and the amount of soluble material is so large that its absorption rapidly furnishes enough pepsine to digest the comparatively small amount of caseine. The mode of secretion of the acid of the gastric juice is less well known than that of the pepsine. According to some observers, it is formed in the pepsine glands, but in a different set of cells from those secreting the pepsine. According to others, special glands exist for the acid, lying in the *right* or pyloric half of the stomach, and called the mucous glands. The general shape of these glands resembles that of the others, but the cells are like little prisms, ranged along the wall, instead of irregular polygons, blocking up the entire cavity. They secrete mucus, and it is said that this mucus decomposes the salt of the food, chloride of sodium, and thus forms hydrochloric acid. (Beneke.) The acid and the pepsine are dissolved out from the recesses of the glands by the water contained in the stomach, and brought together by the same medium, to act simultaneously upon albumen. Neither alone has any true digestive action: non-acidified pepsine and non-peptic acid are equally powerless. Finally, both require to be largely diluted by water. When they are too concentrated, the process of digestion is at once arrested, but can be renewed, as already said, merely by the addition of water.

These facts show why, contrary to a common prejudice, diluted food is more nourishing to the baby than solid. They show also the bad effect of excessive cutaneous perspiration in hot weather, when so much water is evaporated by the skin that not enough is left to dilute the gastric juices, and hence the curds remain undigested and are vomited. They show why concentrated milk is difficult of digestion, and the reason for the injurious effect upon the child of the several circumstances we have noted which tend to diminish the water of the mother's milk, as hot weather, fever, menstruation. They show also an unexpected evil result of too frequent nursing, which, as we have seen, renders the milk too concentrated. In adults, liquids are often more difficult of digestion than solids. In that case there is always in the stomach too small an amount of acid, which becomes unduly diluted by water. The right proportion is about four parts to one thousand of water. We have seen that one great advantage of liquid food was that it increased the amount of pepsine. To increase the amount of acid, solid food is preferable, for it irritates the mucous membrane, and hence stimulates the mucous glands where the acid is formed. In babies, with a natural tendency to a surplus of fermenting mucus, and excess of acid, this irritation is always to be avoided.

It is in this great tendency to acid fermentations that we find the second reason for the exclusion of starch from infant diet. We have shown that the natural modification of starch by saliva is a kind of fermentation, and which, if not arrested at precisely the right point, will give rise to the formation of acids. In all digestions an excess of acid is as injurious as a deficiency, and this is especially true in the digestion of milk, owing to the peculiar effect of acid upon the caseine.

This leads us to speak of the third peculiar characteristic of milk, the presence in it of caseine. This is the albuminous substance of the milk, but it is different in many respects from albumen of meat, of eggs, etc. The albuminous material of meat is solid, and when attacked by the gastric juice it becomes softened, disaggregated, and finally dissolved. This solid albumen may be also dissolved in very dilute solutions of ordinary acids, but if these are at all concentrated, it is coagulated instead of being dissolved. Finally, even from these dilute solutions, it is at once precipitated if the acid be neutralized by the addition of an alkali. In healthy gastric juice, where the acid is always associated with pepsine, the albumen is not only dissolved but transformed, so that it will not precipitate when the acid is neutralized. Were it not for this transformation, which renders the albumen permanently liquid, it would precipitate from the solution as soon as this passed into the blood, which is alkaline, and solid particles would be carried into the capillaries and block them up. When the gastric juice contains an abnormally large amount of acid in proportion to its pepsine, the albumen is indeed often coagulated instead of dissolved, and hence becomes a cause of irritation and of dyspepsia.

Liquid albumen, as that of eggs, does not coagulate in the stomach, unless the acid be unduly concentrated. It is modified or "digested" by the pepsine, in essenially the same way as solid albumen, and requires much more acid for its digestion than the latter. Caseine differs from liquid albumen, by coagulating as soon as it comes in contact with the dilute acid of the gastric juice. The milk "curdles" in the baby's stomach in the same way that it does in a porringer when a thunder-storm has caused its sugar to ferment and generate lactic acid. Upon the nature of the acid thus formed depends some of the principal varieties in the digestibility of the milk. Herein lies the most essential difference between human milk and cow's milk, and on it depends the frequent indigestibility of the latter. The caseine that has been coagulated by the acid of the gastric juice must be so modified by the pepsine that it redissolves again, or rather decomposes into two or three substances, of which some are soluble and others are not.

The soluble products of the modified albumoids are called peptones; the insoluble, parapeptone. This latter passes into the intestine to be digested. During the digestion of milk a substance is formed, intermediate between the caseine and the peptone, called metapeptone. The peptones, dissolved in the gastric juice, cannot be precipitated from it when its acidity is neutralized by the addition of an alkali. This, as we have already said, is the very peculiarity which distinguishes the solution of albuminous substances in gastric juice from their solution in ordinary acids that do not contain pepsine for from these they are readily precipitated. The metapeptone, destined ultimately to be converted into peptone, also remains dissolved when an alkali has been added to the solvent gastric juice; but if an excess of acid be added, it immediately precipitates. It is precisely this precipitation by an excess of acid which is a frequent cause of vomiting in babies at the breast: the curds they reject in such abundance shortly after nursing, consist of metapeptone. They do not therefore result from the first coagulation of the milk, but from a precipitation of that which has been partially digested.

The parapeptone, or the insoluble substance formed at the same time as the peptone, is never changed into peptone, but precipitated as soon as the acidity of the gastric juice begins to diminish, as it always does towards the end of digestion. The acid becomes saturated by the substances it has attacked, and can only retain in solution those which have been rendered permanently soluble by the pepsine. The parapeptone therefore gradually accumulates in the stomach, and finally passes into the intestine, where its digestion is completed. The longer the parapeptone stays in the stomach, the more insoluble it becomes; and if it stays too long, it will become changed into still another substance, of the consistency of soap, and called dyspeptone. This constitutes a second kind of curd, which irritates the stomach much more than the metapeptone, giving rise to an excessive secretion of acid, just as a stone would do. This acid is not gastric juice, for it contains no pepsine; it cannot therefore digest—it only coagulates all coagulable materials into firmer clots, and these, after much pain and disturbance, are finally rejected by vomiting. This vomiting is therefore of different origin and of much greater severity than that which occurs in the early stages of digestion, very soon after the child has taken the breast. The first results from the precipitation of the metapeptone by a slight excess of acid, that is, when there is only a little more acid in the stomach than can be saturated by the food it digests. This may occur with little variation from perfect health: the baby vomits, yet shows no sign of discomfort. But dyspeptone is only formed when the curds first coagulated are so tenacious that they can only be slowly redissolved. The digestion is slackened, the insoluble substances, parapeptones, do not pass readily into the intestine, and, staying too long in the stomach, become the more indigestible dyspeptone. There is therefore a true indigestion, with all its symptoms and consequences. The slight excess of acid, consequent precipitation of metapeptone, and easy vomiting, may be occasioned by, 1st, an excessive secretion from the mucous glands, which mucus readily ferments, and then decomposes too much sugar and salt, so that too much lactic, acetic, and hydrochloric acids are generated. Some children, those called "lymphatic" or "scrofulous," are especially predisposed to this excessive secretion, not only in the stomach, but on all the mucous membranes, as the eyelids, nose, bronchial tubes.

2d. The milk may contain too much caseine for the amount of water. Too little soluble material will be absorbed from the stomach in the first time of digestion to furnish enough pepsine to transform all the caseine in the second time. There will be therefore too little pepsine in proportion to the acid of the gastric juice, or, in other words, the acid will be in slight excess.

3d. The total amount of milk may be in excess, or the child may have swallowed more than its stomach is able to furnish pepsine enough to digest. The facts we have mentioned in regard to the anatomy of the stomach, and the small development of its fundus or peptic-gland portion, show why the pepsine is so much more liable to be deficient in the gastric juice, than the acid. Excessive feeding in babies nearly always means too frequent feeding, and in babies at the breast this determines a special cause of vomiting. It is a rather singular, but well-proven fact, that the longer the milk remains in the breast the more watery it becomes. Conversely, when milk has recently been secreted under the stimulus of suction at the nipple, it is much richer in solid constituents, especially in caseine and butter. A baby that nurses too often is thus exposed to a special cause of indigestion: the food is rendered more concentrated and dif ficult of digestion, at the very time that the digestive powers are weakened by excessive use. A newborn infant should not be nursed oftener than once in two hours, and the daily meals of a child of eight or ten months should not exceed five in number. It often suffices to render the meals even less frequent, to allay vomiting caused by too rich milk. All the above conditions may be present when the child is at the breast, and thus the first kind of vomiting is quite as frequent in nursing children as in those brought up by hand. But the indigestion occasioned by the stony masses of dyspeptone is much more often seen when children are fed upon cow's milk. The caseine of cow's milk is more abundant than in human milk, and it coagulates in much firmer clots, which resist disaggregation for a longer time. There is also less sugar in the milk, so that one source of acid (lactic) is curtailed, and the acidity of the gastric juice diminished. On the other hand, there is a larger amount of butter which is quite indigestible in the stomach, and which, if retained there by a slow digestion, is liable to decompose and generate butyric and other fatty acids. These are of little if any use for acidifying the gastric juice, while on the other hand, they help to coagulate the caseine into tougher masses. We have already shown that the dyspeptone which finally results from this prolonged digestion irritates the stomach, giving rise to a secretion of acid out of all proportion to the pepsine, and constituting therefore no true digestive fluid. The irritation may be intense enough to occasion a catarrh of the stomach, or a congestion of its lining coat, accompanied by excessive mucus secretion. By this, the elaboration of pepsine in the peptic glands is diminished, for when there is congestion the blood in the vessels stagnates instead of circulating rapidly to bring new material. For the same reason absorption from the stomach is checked, thus further diminishing the supply of pepsine, and finally impairing the general nutrition of the body. Or, again, the dyspeptone itself may decompose, and generate fat and fatty acids. It will pass the pyloric orifice of the stomach quite unprepared for intestinal digestion, and irritate the intestine so as to occasion diarrhœa. The evacuations consist of mucus and fluids secreted from the intestine, the masses of undigested food themselves pass slowly down the canal, often causing a temporary obstruction. The slower the progress, the more completely is the water absorbed, constipation succeeds to diarrhœa, and the evacuations become hard and dry. Thus pain in the stomach, vomiting, diarrhœa, constipation, general failure of nutrition may be the result of feeding a young baby upon rich cow's milk, injurious precisely because so rich. Precisely similar disturbance is caused by human milk when the caseine in it is in excess of the normal proportion. With the excess of caseine there is gener ally an excess of fat globules, and the milk is remarkable for its whiteness and opacity.

Besides the above-mentioned forms of vomiting where the milk is curdled, there is another where the milk is rejected almost unchanged. This generally indicates more serious trouble, for it implies a deficiency in the secretions of the stomach, or else an excess of alkaline mucus dependent on catarrh, and which has neutralized the acid. The baby is then generally ill enough to require a physician.

In all these cases where the caseine of milk passes to the condition of dyspeptone, and remains with water or some watery liquid undigested, the milk must be diluted. This dilution acts in two different ways. In the first place, it favors the absorption of a soluble substance into the blood, and thus provides for the secretion of pepsine to digest the insoluble, the caseine. In the second place, it dilutes the acid of the gastric juice, and thus prevents it from coagulating the caseine too firmly. In a word, as might be expected, the addition of water to milk helps the digestion in precisely the way that the water originally contained in the milk is intended to do. Where the child is fed by hand, of course the diluting fluid is easily added to the milk in the bowl. Where it is at the breast, the same end is reached by giving a table-spoonful or more of this fluid just before nursing. Instead of plain water it is preferable to use some substance which by its physical consistency is able to hold the caseine clots in suspension, thus protecting the lining membrane of the stomach from irritation, while they are being prepared for dissolution. Thus may be mixed quite thin and transparent mucilage with (boiled and skimmed) cow's milk, and added the desirable quantity of sugar and salt, or soda. With the caseine of this mixture the gastric juice will get into very slow contact indeed, thus producing a looser, because a more gradual and interrupted coagulation, on which the digestive liquids and the peristaltic motion of the stomach have a better opportunity to exert their influence. Looking for a substance, which, while fulfilling that object, is absolutely indifferent, from a chemical and physiological point of view, it is gum arabic. Its decoction, therefore, as it is not influenced by the digestive liquids, and is not absorbed, acts mechanically only. If I meant to write a eulogy on gum arabic, I should but add, that its unpretending and unaggressive nature renders it particularly fit for an addition to children's food, when, in more advanced years also, their irritated intestines require a soothing addition to the necessary nutriment.*

An indifferent substance of this sort may be all that

* Dr. Wertheim's book on the "Dietetics of Nurslings," published in Munich in 1860, has greatly encouraged me to insist upon my plan of diluting caseine. Already Van Swieten, in the fifteenth century recommends decoctions of wheat or barley for this purpose.

is desired for very young infants: when they advance in weeks and months, they may require a substance, which, while fulfilling the indication of keeping cow's milk suspended, will act as a nutriment at the same time.

The selection of articles of food, which are, at the same time, of a mucilaginous consistency, and nutrient, is perhaps not so difficult as it appears to be. At all events, we shall have to avoid such farinacea, which, like potatoes, rice, and arrow-root, contain an overwhelming amount of starch and cellulose. All farinaceous food contains, of course, a certain proportion; but those articles should be selected in which starch is least abundant. However, to the question of the digestibility of amylum by the infant, I shall have to refer again.

There are a few only of which I make any use in the feeding of infants. To justify my selection, I must—although I have carefully avoided the quotation of figures and statistics—beg your permission for the following few, which contain in *per mille* the proportions of the constituents in a number of articles:

Albuminous substances:—In wheat, 135; barley 123 rye, 107; oatmeal, 90; Indian corn, 79; rice, 51.

Starch:—In rice, 823; Indian corn, 637; wheat 569; rye, 555; oatmeal, 503; barley, 483.

Fat:—Indian corn, 48; oatmeal, 40; barley, rye, wheat, rice, but little.

Salts (principally phosphates):—Barley, 27; oat meal, 26; wheat, 20; rye, 15; Indian corn, 13; rice, 5.

Potassa is mostly found in wheat; magnesia in wheat and Indian corn; lime in oatmeal and barley; iron in barley; phosphoric acid in barley and wheat.

From this small list you would exclude, for their large percentage of starch, as regular additions to infants' food, rice and Indian corn. For their large percentage of albuminous substances, you would select wheat, barley, rye, or oatmeal; for their high percentage of salts, so absolutely required in the healthy organization of the blood, and the rest of the tissues, barley, oatmeal, and wheat.

Your list would consist of these three, then: barley, wheat, and oatmeal, as possessing all the necessary elements of nutrition, while holding so much amylum as to render it dangerous, when in good preparation. Amongst the three, barley appears to be preferable for its nutritiousness and digestibility. Moleschott claims thirty-six ounces a day as a sufficient amount of food for a hard-working man. There is another advantage, I think, it has over the other cereals mentioned, viz. that it bears the removal of the husk, after grinding, better than any other. The large proportion of the proteinous substances in wheat and rye is deposited in the inner layer of the husk, which is not generally used. (Payen.) Not sc in barley, where the protein is spread on a larger portion of the grain. Thus, the husk may be removed, and the consistency made fine, without diminishing, to any considerable extent, the nutritive value of its constituents.

Barley and oatmeal are the two substances I mostly employ, as their chemical constituents are nearly alike, with the exception of a large portion of fat in oatmeal, which is not found in barley. Barley water, or thinned and sweetened oatmeal gruel, may be given to the child at the breast as above described. The indications for the use of one or the other lie in the condition of the infant. Where there is a decided tendency to constipation, I prefer oatmeal; where there is no such tendency, or perhaps even a tendency of the bowels to be loose, I employ barley. The "prepared" barley is a good preparation; but it is safer, as no mistake or deception can take place, for every mother to grind it in a common coffee-grinder of her own. A teaspoonful of either is boiled in from three to six ounces of water, with some salt, for twelve or fifteen minutes, the decoction to be quite thin for very young infants, thicker for later months, and then strained through a linen cloth. Infants of four or six months are to have equal parts of this decoction, which ought to be made fresh for every meal; and (boiled and skimmed) cow's milk and sugar is to be added. At an early age, the thin decoction, at a later, the milk ought to prevail in the mixture, which ought to be given at a temperature of 80--90°, ought to be neutralized, when acid, with a few grains of bicarbonate, or carbonate of potassa or soda, and, until infants are eight or ten months old, thin enough to be taken through a nursing-bottle.

Liebig recommends a mixture of two pounds of wheat malt and one ounce of carbonate of potassa. Of this mixture a table-spoonful is to be cooked with milk and water. He wishes to develop sugar in and out of the food rather than to add it in substance. The recommendation is a good one. But the object of this paper is to show in what manner substances known to, and in the grasp of, every part of our population, can be employed as a perfectly harmless, reliable, nutritious article of diet.

Such substances must have several qualities. They must be perfectly simple and recognizable. They must be found for sale everywhere. Their preparation must be perfectly simple and easy.

For this reason I prefer the unground barley to the so-called "prepared" article. For the same reason I cannot encourage the use of patented articles of food, although there may be some which deserve attention and credit. I might name some which now and then have proved beneficial in my own hands; and also some, which, when I had the analysis made of two different bottles of the same box sent as specimens, yielded greatly varying results. Amongst the axioms we ought not to lose sight of is, that unvarying truth is in nature only; and that trade, or money, has no soul nor conscience.

In the preparation of cow's milk, therefore, for the use of babies, it is first necessary to dilute the caseine, then to add to the nutritive material of the milk by the choice of vegetable decoctions instead of plain water to effect this dilution. These vegetable decoctions, like the milk they dilute, contain albumen, fat, and salts. But instead of sugar they contain starch, destined finally to be changed into sugar, but whose decomposition in the stomach often also gives rise to acids, which mix with those of the gastric juice, and increase its effect. But as the sugar obtained from starch cannot supply all the saccharine matter necessary for the baby, there must be in his food ready-made sugar as well.

When speaking of the food of the nursing mother we have already explained some of the peculiar uses of non-nitrogenous substances, that is, fat, starch, and sugar. We have said that they may be compared to the coal that furnishes steam to a locomotive. They do not help to build up the framework of the body, but their combustion in the body gives off heat, and the heat is necessary on the one hand to all the chemical processes of nutrition, and on the other to the evolution of motor force: without which neither the tissues could grow, nor the muscles contract, nor the limbs move. The body would be an inert mass, like a locomotive whose fuel is exhausted. It is not alone by the feeble limbs of a baby that we can measure the muscular force expended in its little body. There are internal as well as external muscles, and before the child can walk the work done by the internal muscles is the most important. The beating of the heart, the expansion of the lungs, the rhythmical contractions by which the food is propelled along the alimentary canal, all imply incessant muscular contractions. The calculation has been made that the work performed by the heart is equivalent to raising its own weight to nearly five hnndred feet every minute. The muscular force expended in the movements of respiration in the course of the day would suffice to raise to the height of three feet about 24,000 pounds. These calculations are made for the adult, but the difference in the baby is much less than for the voluntary muscles.

Of the three kinds of food especially destined to furnish heat for this enormous amount of motor force—sugar, starch, and fat—the first is directly absorbed from the stomach, the second incompletely modified there, and the third, fat, not digested at all until it reaches the intestine. Since it is desirable that for the baby as large a proportion as possible of the food should be digested in the stomach, sugar is a more appropriate "heat food" than either starch or sugar. Its deficiency, by curtailing a source of motor force, may cause constipation in another way than that already mentioned, namely, by diminishing the motor force of the intestine. In human milk, where there is no starch, there is a much larger proportion of sugar than of butter, while in cow's milk the butter is doubled.

The relatively small amount of free alkali in cow's milk is a serious drawback, as, sometimes, even fresh cow's milk has no alkaline or neutral reaction, and is very apt to undergo acid decomposition within a very short time, especially during summer. It is advisable, therefore, to add an alkaline salt (the carbonate or bicarbonate of potassa or soda) to cow's milk, and best at once, when the milk is put aside for the infant's use. Whichever is selected may not make a great deal of difference under otherwise normal circumstances. Thus, I add 1–2 grains of either of the salts to every meal of the new born, besides a small quantity of common salt—chloride of sodium—and a larger dose in proportion to age.

The addition of chloride of sodium to the food is the more important the more the milk is mixed with a vegetable decoction. Carnivorous animals crave no salt; herbivorous, however, a great deal, although in their food the absolute amount of chloride and sodium is as large as in that of the former. They are easily drawn by hunters into fields and woods strewn with salt; and the instinct of mankind has early taught how to add more salt to herbaceous than to animal food. Liebig has tried to explain this fact by the chemical relation of chloride of sodium to the sugar into which starch has been transformed by the effect of saliva and pancreatic juice. But it appears that G. Bunge (*Zeitschrift fur Biologie*, 1873) comes nearer to a satisfactory chemico-physiological explanation. We find that the craving for salt grows in proportion to the amount of potassa salts contained in the food. In the food of herbivores there is twice or even four times as much potassa as in that of carnivores; potatoes, with their large amount of potassium, combined with chlorine with phosphoric and citric (pomic) acids, necessitate the addition of large quantities of chloride of sodium. In the food of carnivores, however, who eat whole animals, one equivalent of potassa is nearly balanced by one of soda and one of chlorine.

Potassa salts and soda salts both exist in the blood, the former principally in the blood corpuscles, the latter entirely in the serum or watery part of the blood. There is chloride of potassium in both corpuscles and serum, but phosphate of potassa in the corpuscles alone. Now if there should ever be in the blood more phosphate of potassa than can be taken up by the corpuscles, it will be immediately decomposed by the chloride of sodium in the serum—chloride of potassium and phosphate of soda are formed, and these are both rapidly eliminated by the kidneys, and pass away in the urine. By this means, chloride of sodium is carried away, and must be replaced: in other words, vegetable food requires the addition of a great deal of salt.

The substitution of cow's milk for woman's milk necessitates the addition of salt, for a similar reason; for while 1,000 parts of human milk contain only 0.70 chloride of potassium, 1,000 parts of cow's milk contain 1.30.*

In this connection, while speaking of different artificial modes of feeding infants, I ought to allude to Liebig's artificial milk for babies, which deservedly has attracted the attention of the world.

According to Dr. Letheby (*Chem. News*, Jan., 1869), the food which Liebig recommends for infants is a preparation of malt, with wheaten flour and milk, to which a little bicarbonate of potassa has been added. The preparation is made by mixing one ounce of wheaten flour with ten ounces of milk, and boiling for three or four minutes; then removing it from the fire and allowing it to cool to about 90°. One ounce of malt-powder previously mixed with fifteen grains of bicarbonate of potassa, and two ounces of water are then stirred into it, and the vessel, being corked, is allowed to stand for an hour and a half, at a temperature of from 100° to 150°. It is then put once more upon the fire, and gently boiled for a few minutes. Lastly, it is carefully strained to remove any particles of husk, and then it is fit for the

* When food containing an excess of salt is used, it is necessary to reverse the above process, and add substances which contain potassa. Scurvy among sailors has been traced to the use of salt meat, and cured by the addition of potatoes and other vegetables containing large amounts of potassa, and which carry off the excess of salt in the way described in the text. (Garrod.)

child's food. The composition of the food, according tc Liebig, is as follows:

	PLASTIC MATTER. OUNCES.	CARBONACEOUS MATTER OUNCES.
10 ounces of milk	0.40	1.00
1 " " wheat flour,	0.14	0.74
1 " " malt flour. .	0.07	0.58
	0.61	2.32

The relation of the plastic to the carbonaceous matter being as 1 : 3.8, which is the right proportion for the food of children.

The effect of the malt-flour is to transform the starch into glucose, or grape sugar, the only form of sugar assimilable to the tissues, and thus the mixture gets thinner and sweeter as it stands; and the bicarbonate of potassa is added to facilitate the change and to neutralize the acid constituents of the flour and malt.

It looks as if the results of this food must be uniformly good, and still the disappointments in regard to its effects have been as many as its recommendations have been eulogistic. I have employed it myself, with varying results. I believe that the attention required in preparing the food is the source of failures in most cases. Common sense is not at all a prerogative of every mother and nurse: and it appears that the requirements laid down in Liebig's plan demand too great a complication of cerebral functions on the part of cooks. The attempts at shortening this cooking process, by preparing for the market some similar articles requiring less attention and time, are to be ranked amongst the patent merchandise of which I spoke before. It was one of these "prepared Liebig's foods" on which I made the experiments I mentioned.

One more word upon the dangers to be guarded against in the use of cow's milk. Of these, the principal that is alleged is, its adulteration by amylum, gum arabic, lime, and other articles. Our country places, however, do not suffer on this account; nor do I believe that much of this sort of adulteration takes place in the city. As the tests for the accused articles are easy, I have frequently tested for them, in former years, in different parts of the city, but did not find them.*

Mixture with water is rather a nuisance than a great danger. But it must be taken into account before diluting the milk, as otherwise this may be unduly deprived of nutritive material. Improper cow's feed is a danger, certainly, but still I believe that the large number of

* Examination for starch or farinacea:—A small quantity of tinct. iod. yields a blue color.

Gum arabic:—Coagulate milk with acetic acid and filter; alchol poured into the serum yields a viscid opaque deposit.

Soda:—Effervescence in adding acetic acid (vinegar).

Lime:—Add sulphuric acid and filter; nitric acid added to the filtered serum, yields a heavy and insoluble deposit of sulphate of lime.

deaths attributed to swill-milk before, during, and after the swill-milk agitation in New York, years ago, are to be sought for elsewhere.

The desire of parents to procure the milk of one special cow for their infants, I believe to be based upon a mistake. As we know to what extent chemical and vegetable materials will be eliminated through the milk-glands, in all mammals, we must infer that the milk of each cow possesses a distinct individuality—according to her food, state of digestion, etc. Hence, the child who has become accustomed to one, will suffer from the abrupt transition to the milk of another animal—transition, nevertheless, which is often inevitable. There is much less danger in habituating the child to the average milk of all the cows of a farm, as, moreover, the milk of a special cow may, by accidental changes in the food, undergo frequent and unexpected changes. I have always advised the plan of giving the average milk of a farm, and have never been sorry for the results, in all parts of the city. Condensed milk, also, is to be recommended in the feeding of infants, the addition of loaf-sugar, that is made in the manufactories, being rather an advantage than otherwise. When it is to be used, it must be diluted according to the degree of condensation, which is generally from 4 to 5 to 1.

The above directions are nearly all based upon the changes undergone by the milk in the stomach. Yet, as we have said, a certain portion of even infants' escapes digestion in the stomach and passes on to the intestine, namely, all the starch that has not become glucose, all the parapeptone or dyspeptone left from caseine, finally, all the butter, and a certain proportion even of the soluble salts.

The digestive apparatus of the intestine is more complicated than that of the stomach. Instead of one digestive fluid, the gastric juice, there are then the bile, the pancreatic juice, and the intestinal juice. All the glands of the stomach are contained in the thickness of its mucous membrane; but the intestine receives two of its true digestive fluids from enormous glands lying outside—the liver, furnishing the bile, and the pancreas. Again, the glands which are imbedded in the intestinal mucous membrane present many more varieties than do those of the stomach. In the first place, there are straight tubes placed side by side like the peptic glands, and lining the entire length of the intestine. These are called the glands of Lieberkuhn. Then there are glands shaped like a bunch of grapes, which are found only in the first part of the intestine immediately succeeding the stomach—a segment about twelve inches long, and on that account called the duodenum. It is into this segment that the bile and pancreatic juice are poured. The grape-like glands are called the glands of Brunner. Then there are little patches called Peyer's patches, made up of groups of small round glands, like little bags: others, similar, are disseminated here and there. All these glands are found in what is called the small intestine, a tube immensely long in comparison with the size of the body, and which lies coiled up in the centre of the abdomen. At the right side, low down near the hip bone, this tube opens into another, much larger in diameter, and with which it communicates by means of a valve. This larger tube encircles the abdomen, and terminates in the rectum and anus. It is called the large intestine.

Like the small intestine, the large contains glands that furnish a secretion which lubricates the mucous membrane. But it is unnecessary to describe them particularly, for this secretion has nothing to do with digestion: it only serves to facilitate the progress of the contents of the intestine, which here become feces, destined for secretion. In the large intestine nothing is digested, but water is continually absorbed from the residue of food, so that the fecal mass assumes continually firmer consistence as it descends the canal. The water is taken up by the veins, just as it is in the stomach, and with the water, all substances directly soluble in it. On this account it is possible to feed a person for a little while by injections of fluids into the rectum. But in regard to this matter, a serious oversight is often committed. The rectum and the large intestine absorb, but they do not digest; that is, they do not transform food into substances that may be assimilated by the tissues

When substances that have been dissolved, but not so transformed, have passed into the blood, they do not stay there—they are not assimilated, but pass out unchanged into the urine. If undigested but liquid albumen be thrown into the veins, it appears in the urine; and so with ordinary sugar. But if digested albumen or grape sugar be injected, there is no trace of a foreign body in the urine.

When, therefore, on account of his inability to swallow, or of incessant vomiting, the attempt is made to feed a patient by the rectum, it is necessary not only to dissolve the articles of food, but to effect in them the apparently trifling but really all-important transformations that ordinarily take place in the stomach. Thus sugar and starch must be converted into glucose; meat or the caseine of milk must be changed to peptone, by means of an infusion of calves-stomach; fat, which, as we shall show, is digested in the small intestine by means of the bile, the pancreatic and intestinal juice, must be emulsified by the same fluids artificially procured. These precautions are hardly ever taken: if they were, nourishment by the rectum would be more often successful—often, indeed, a means of saving life at a most critical emergency.

There is one other point of great interest in regard to the absorption from the rectum, and that is the increased secretion of pepsine that may be determined by such injections, as has already been described. We have said that a remarkable efficacy for this purpose attached to a substance called dextrine, a carbohydrate into which starch changes before it becomes sugar.

In many cases of vomiting that depend upon an insufficient formation of pepsine, injections of solutions of dextrine will enable the stomach to resume its functions. This remedy, recommended by Schiff, has not, that I know, been applied to the treatment of gastric indigestion in babies, but it would be most rational to do so.

The apparatus for absorption in the small intestine is more complicated than in any other part of the alimentary canal. The glands of which we have spoken do not open upon a comparatively smooth surface* as in the stomach, but underneath and between an innumerable multitude of comical projections from the mucous membrane, called villosities. We have already compared these to the rootlets of a plant, which reach down into the soil to absorb the nourishment. Their number is prodigious.

Each little cone consists of a network of blood-vessels held together by fine fibres entirely covered with a layer of prismatic cells, and traversed by a central canal. Under the microscope the villus looks like the finger of a glove. The fluids contained in the cavity of the intes-

* Leaving out of sight, for the moment, the folds of the mucous membrane.

tine that have been sufficiently prepared for absorption, pass through the cells, and thence into the blood-vessels or into the central canal. Into the first pass materials that are or have been rendered soluble in water, and which can traverse the walls of the blood-vessels by endosmosis. Into the central canal passes the insoluble fat, that, by intimate mixture with the three digestive fluids of the intestine, and especially with the bile and pancreatic juice, has been made into an emulsion. In this state the particles of the fat are very finely divided and suspended in fluids in which it could not dissolve, just as oil is suspended by mucilage or the yolk of an egg. This white fatty emulsion is called chyle, and its infinitesimally fine particles force their way through the walls of the cells (the epithelium) covering the villosity, and so into the central canal called on that account the chyliferous or lacteal vessel.

Another part of the fat, instead of being emulsified, is saponified. All fats are composed of two substances—glycerine, with which every one to-day is familiar, and one or more acids, called fatty acids. When oil is mixed with an alkali, as soda or potassa, it is decomposed. The alkali combines with the acid to form a salt which is soluble and easily absorbed, and the glycerine forms compounds with phosphoric acid.

All the fluids of the intestine are alkaline, as those of the stomach are acid. In this way everything which has escaped digestion in the stomach is immediately brought into contact with fluids of exactly opposite chemical reactions. The bile contains abundance of soda and potassa, and the pancreatic juice also. When there are not enough phosphates in the food, the pancreatic juice acts imperfectly on the fats, and thus when the milk is poor in these important salts the butter is imperfectly digested.

When there is enough alkali to decompose the fats, but not enough to combine with the fatty acids thus set free, these remain in excess in the intestines. They turn the yellow coloring matter of the bile green, and, as has already been said, the passages with which the bile is mixed become green, and thus offer the first indication of deranged digestion. But if the acids become more abundant, they may succeed in neutralizing the alkalinity of the three great digestive fluids, the bile, pancreatic juice, and intestinal secretion. As a first result, fat can no longer be emulsified nor absorbed, and decomposing in the intestine, generates new acids. Further, the presence of the bile seems to be especially necessary to prevent the putrefaction of the food. When there is an excess of acid, less bile is poured out, perhaps because less fat is absorbed from which the bile may be made. In its absence, part of the food does putrefy, generating gases that painfully distend the bowels, causing "wind colic."

Anything that deranges the chemical composition of the intestinal fluids is liable to produce a similar effect; for in the intestine, whatever food is not digested tends to putrefy and generate gases.

This generation of acids and gases in the intestine is much more frequent in babies than in adults. Colic and diarrhœa are as common accidents during the process of intestinal digestion as is vomiting while the food remains in the stomach. This shows that the intestine, like the stomach, differs notably from that of the adult. The following are the principal points of difference:

1st. The mucous membrane of the bowel in children secretes an abundant mucus, which is liable to ferment and form acids that neutralize the alkalinity of the digestive fluids, interrupt the digestion, and thus permit the food itself to decompose into acids. These have therefore a double origin.

2d. The food of young babies, milk and farinaceous substances, decomposes with especial facility, and the products of decomposition are all acid. The starch that has escaped complete digestion by the saliva, and which is not entirely transformed by the pancreatic juice, gives rise to lactic acid. Butter, in the least excess, will decompose into butyric, acetic, caproic, and other acids. Caseine that has staid long enough in the stomach to be changed to dyspeptone (see p. 00) is with difficulty attacked by the intestinal fluids, and having irritated the stomach, decomposes in the intestine.

3d. It is probable that all the glands which supply the intestine are yet incompletely developed in young babies, so that their secretions are less well adapted for digestion than in adults. We have already spoken of the experiments which show that the pancreas acquires its power of digesting starch even later than the salivary glands. The liver, relatively larger before birth than at any time afterwards, is very large in young babies. But the liver has many other functions besides that of the secretion of bile. It manufactures grape sugar, that passes into the blood, and in the fœtus is found in all young and rapidly growing tissues, just as fat is in after life. At this time, moreover, if not always, it is concerned in the formation of red blood corpuscles. While these two functions, and possibly others as well, are so active, it is not improbable that the third, with which the adult liver is most popularly identified, should be imperfectly performed, and that the bile should be a less perfect digestive fluid. The bile is partly composed of waste elements, destined to be thrown out of the body, and there is comparatively less waste in the body of a rapidly growing child than in an adult who has ceased to grow. There is therefore less to make bile of. But in the absence of bile, the contents of the intestine are liable to decompose and generate gases. Of the small glands imbedded in the walls of the intestine, some are well developed at birth, but others not till long after. The groups called Peyer's patches are very imperfect—so much so that they are not liable to disease; and typhoid fever, in which they are invariably inflamed, is extremely rare in young children.

4th. The digestive apparatus of babies is much less under the control of the brain and spinal cord than is that of adults. In exactly what this control consists, would be difficult, in our present state of knowledge, to define, and still less explain within the compass of this essay. But this much is certain: when anything has weakened the central nervous system, that is, the brain and spinal cord, acids and gases are very apt to form in the intestine. Thus in adults, after great bodily fatigue or mental exhaustion, arrest of digestion, cramps, distension of the abdomen by wind, are common occurrences, especially in women, and above all in hysterical women, in whom the brain and spinal cord are incapable of much endurance. We must infer that under these circumstances there has been an insufficient secretion of digestive fluids, so that the food has been left to itself, to undergo spontaneous decomposition or acid fermentation. In babies, the brain and spinal cord are incompletely developed, and their control over the intestine is therefore permanently as weak as it occasionally becomes in adults. When the nervous system is further weakened by the heat of summer, the tendency to acid fermentations in the intestine is increased, and this is one reason why diarrhœa is so frequent a disease of children in summer.

The same weakness of the nervous system may become a cause of diarrhœa in another way, namely, by an increased rapidity in the movements of the bowels. There are certain nerves that run from the spinal cord to the intestine, whose action, when powerful, tends to moderate these movements, but if it be weakened, the bowel contracts irregularly and precipitately, and propels its contents so rapidly that the food does not have time to digest. The surface of the bowel is irritated by the undigested lumps that pass over it, and pours out watery secretions; the passages become frequent, and contain at once the undigested food, abundant liquid, and slimy mucus. Thus diarrhœa, that may result from so many other conditions, may be set up merely by the exhaustion of the nervous system that results from heat.

As the disorders of the stomach in babies may be approximatively estimated by the nature of the vomiting which is their first symptom, so the various derangements in the intestinal digestion may be classed according to the nature of the stools. We will recapitulate in a few words what has been said on this subject. When the passages are green, there is an excess of acid in the intestine, that has changed the yellow coloring matter of the bile. This excess of acid always comes from a fermentation of some part of the food that has escaped digestion—starch, giving lactic and acetic acids; butter, giving butyric and other fatty acids, and dyspeptone, from the caseine, which finally decomposes into acid similar to those coming from fats. The fermentation may be caused by an excess of decomposing mucus.

All the digestive fluids of the intestine are alkaline. When part of the food becomes acid and neutralizes this alkalinity, the digestion of another part is therefore arrested.

These acid passages excoriate the nates, and occasion red eruptions. In bad cases the mouth often becomes sore. When the acids thus formed pass into the blood, they tend to dissolve and carry off the phosphates, and thus to interfere with the building up of tissues, and especially of bones.

When the passages are watery and yellow instead of green, they indicate too rapid peristaltic movements of the bowels, with excess of secretion.

These rapid movements always imply a weakening of the spinal nerve influence distributed to the bowels. When the stools are entirely watery, this is often the cause of the trouble. When lumps of hard curd are found in the passages, the cause of the diarrhœa is generally the irritation of the bowel by caseine that has escaped digestion in the stomach, and become too indigestible for the intestine.

Watery, *colorless*, and very frequent stools indicate a peculiar irritation of the bowels that may become extremely dangerous, or already indicate the beginning of cholera infantum. In this disease, all the secretions of the intestine are arrested, including the bile; the fluids of the stools are poured out from the blood-vessels. By a diarrhœa of this kind the system may be drained as by a hemorrhage. The treatment of such grave disorder belongs entirely to the physician.

The green, watery or lumpy passages may sometimes be remedied by the mother. Chalk-powder and carbonate of magnesia are remedies much used to directly neutralize the acid; subnitrate of bismuth, in rather large doses, has a very remarkable power to arrest the fermenting process that gives rise to acids.* When, instead of diarrhœa, there is constipation, and the green stools are infrequent and accompanied by pain, soda or magnesia or bicarbonate of potassa are selected to neutralize the acid, for they do not constipate, as the chalk and carbonate of magnesia do.

Whenever cow's milk is used for babies, 1–2 grains of bicarbonate of soda or of potassa should be added to each meal. Still better is it to add a teaspoonful of lime-water to each pint of milk that is obliged to stand for

* Eustace Smith strongly recommends, in addition, aromatics which stimulate the intestine, as the aromatic powder of the Pharmacopœia, containing cinnamon, ginger, cardamom, and nutmeg.

several hours, and which is always liable to become acid while standing.

In very young babies, green stools frequently depend on an irritation of the mucous membrane, and abnormal secretion of mucus. They may be remedied by injections of mucilaginous decoctions, which soothe this irritation, as decoction of marsh-mallow, slippery elm, starch, or gum arabic.

The lumpy stools must be treated by methods calculated to dilute the caseine and render it more digestible by the gastric juice. The dilution of the milk in the way already described is always necessary in these cases. Afterwards, means for increasing the amount of pepsine in the stomach may be employed. Pepsine may be given with milk, or the method of Schiff adopted, of injections into the rectum of dextrine, that, being absorbed, will furnish material for the secretion of pepsine.

The watery stools, without lumps, often depending upon a depressed condition of the nervous system, require tonic treatment. Cold bathing and change of air are the most important domestic remedies for this purpose. In very hot weather, a few drops of brandy should be given, as will be described further on. When a gastro-intestinal catarrh has been set up, that is, when the mucous membrane of the bowel has been irritated so as to pour out abundant mucus or "slime," medical advice must always be sought. In these cases the child must be deprived of all food for three, six, or ten hours, and afterwards the quantity of milk must be reduced for several days.

In all cases of infantile diarrhœa, warm poultices should be applied to the abdomen.

How are babies to be fed, from a spoon, cup, or nursing bottle? The only physiological method consists in employing the latter. Neither spoon nor cup prevents food of too hard a consistency from entering a baby's stomach. The fine preparation of the infant's food is equivalent to an adult's careful mastication. The greatest mistake on the part of mothers and nurses is that thick food is more nutritious; the truth is, that the nutritive power of food grows, *ceteris paribus*, with its dilution. Besides, the main requirement for a normal digestion is a *gradual* introduction of food into the digestive organs. Gastric disorders are, at every age, the legitimate result of hasty deglutition. The secretion of gastric juice taking place gradually, ought to find for its function but a corresponding amount of food. Moreover, the act of sucking itself is indispensable for a sufficient secretion of the digestive fluids. The digestive duct is an anatomical and physiological contiguity from lip to rectum. The sucking movement excites the flow of such saliva as is formed in the salivary glands, and also stimulates the rest of the digestive glands. Thus a healthy digestion requires that food should pass the anterior portion of the digestive tract slowly, and that, for universal use, the nursing bottle should not be dispensed with before a sufficient number of teeth enable an infant to masticate. The importance of this physiological fact has been well appreciated, although sometimes exaggerated. Thus, Thomas Ballard, a dozen years ago, tried to attribute almost all the diseases of young infants, and even some of their mothers, to "fruitless sucking" on empty breasts, fingers, etc. If it was his intention to impress upon the minds of his readers the close physiological connection of all the parts of the digestive tract with each other, we can well afford to overlook the extravagant conclusions of many of his statements.

To what extent do these general rules of infant diet require modification during the heats of summer?

It is well known that summer is the period of the largest infant mortality; also that this is principally due to affections of the digestive organs; finally, that the prevalence and severity of such affections is, other things being equal, in proportion to the degree of heat. Children are not often killed directly by heat, as are adults—they are not sufficiently exposed to the sun to succumb to the effects of insolation. They do not die merely because they are hot, for they do not get hot enough to die from rise of temperature alone; but they die when the heat has weakened the digestion, reduced nervous force, and thus paved the way for gastro-intestinal catarrh and cholera infantum. How does heat do this? The temperatures to which the children we are considering are exposed, range from 90° to 102° at the hottest. Now, even should the temperature of the body reach this latter point, the rise would be insufficient to cause the coagulations of myosine (Kuhne), the paralysis of the cardiac fibre (Obernier), the expansion of the gas of the blood (Eulenburg and Vohl), that have been affirmed or observed in cases of sunstroke. Still less need we expect the multiple fatty degenerations known to be the invariable consequence of a long-continued excess in the production of animal heat. But in the majority of cases in question, the temperature of the body does not rise in proportion to the external heat. The variations are much more delicate than in cases of sunstroke or fever, and accompanied, not by structural lesions, but by the functional alterations of nutrition that necessarily precede such lesions. These latter serve, like the magnified diagrams on a lecture screen, to indicate the nature of changes whose real proportions are too subtle to be appreciated except by inference.

In relation to the effect of an external rise of temperature upon the lining of the body, three points may be considered established:

1st. The external temperature primarily affects cutaneous sensitive nerves.

2d. The internal temperature of the body is modified by the reflex action of certain parts of the nervous system, to which the cutaneous impression has been transmitted.

3d. The variations of internal temperature are accompanied by, if they are not dependent on, modifications of the nutritive processes. These latter are measurable by differences in the consumption of oxygen, and elimination of carbonic acid gas.

The excitation of the cutaneous nerves is in proportion to the difference between the temperature of the animal body and that of the surrounding medium. When an animal is plunged into a bath of cold water, or cold air, there is at first a refrigeration of the surface which communicates a portion of its heat to the medium. In a very short time, however, there is a rise of the internal temperature, as measured by a thermometer placed in (Liebermeister) the axilla or rectum. This rise compensates for the loss of heat by radiation, and thus serves to maintain the so-called constancy of temperature of warm-blooded animals,—constancy, however, which has been shown to include variations of two or three degrees (Richardson). At the same time, with that rise of temperature, there is an increased metamorphosis of tissue, indicated by an increased consumption of oxygen, and increased elimination of carbonic acid gas. As the physical and chemical action of cold gives no explanation of the rise of temperature determined by it, we must ascribe the increase of heat to this very increase of molecular metamorphosis, and that, again, to the reflex stimulation of some part of the nervous system. The direct effect of cold is to depress nutritious activity, that is, whenever the temperature of the blood is lowered. The same mechanism that prevents this temperature from following the variations of the external medium, secures a result precisely the reverse of that which would be the direct effect of cold, namely, increased activity of nutrition (Roehrig and Guntz). Precisely the reverse effects are produced by a warm internal medium. When a guinea-pig was kept in a bath whose temperature gradually fell from from 42.9 to 40.8 (centig.), there was a marked diminution in the consumption of oxygen and in the elimination of carbonic acid. At the same time, the internal temperature rose. During fœtal life, where there is no difference between the temperature of the surface of the body and of the surrounding medium, the destructive metamorphosis of tissue is very slight, but the temperature is maintained by the influence of the medium; also by the predominance of the chemical action of combination over that of decomposition. "Heat is evolved when substances combine; it becomes latent when substances decompose." But at the very moment that the child by birth is transferred to a medium of varying temperature, it is also provided with a mechanism which constantly compensates for loss of heat from the surface by increased production of heat at the interior of the body. The same cold air that cools the skin excites the sensitive nerves, and this excitement, in one way or another, determines, as we have seen, increased metamorphosis of tissue and rise of internal temperature, the latter phenomenon being partly at least dependent upon the former.

The same modifications, that are determined precisely by experiments with the cold or warm bath, take place spontaneously in summer or winter. The body loses weight from October to April, and gains from May to August. In March the loss is equal to 0.95; in August, the increase is equal to 0.70 (Richardson).* This shows that the metamorphosis of tissues is rapid in cold weather, when the cutaneous nerves are stimulated by a marked difference between the temperature of the skin and that of the atmosphere; while in warm weather, when the difference between the body and its medium is greatly diminished, those same nerves remain unexcited, and the metamorphosis of tissue is slackened.

When the waste of tissue is diminished, the necessity for new supply is diminished—*pari passu*—the appetite is less, and the vigor of all the processes of nutrition suffers. It is on this account that the

* These effects in the human being are modified, however, by the increased quantity of food taken in cold weather.

digestive organs are particularly liable to derangement in hot weather, or in a more tropical climate than that to which the individual was born, and to which his nervous system is naturally adjusted. When the heat becomes excessive, the cutaneous nerves do not merely suffer from loss of their appropriate stimuli,—they are exhausted. The properties of sensitive nerves are very rapidly exhausted by heat, as may be shown by experiment. Excessive heat will determine anæsthesia, as complete as that induced by chloroform, and the movements of the heart are arrested in tetanus. The spontaneous elevation of atmospheric temperature never, of course, is sufficient for such extreme effects; but a degree of exhaustion of the nerves far below the point of anæsthesia, or of enfeeblement of cardiac contractions, far removed from their complete arrest, is still sufficient to greatly interfere with the nutritive processes dependent on the integrity of nerves and heart.

That the action of heat and cold upon the body is effected by means of the sensitive nerves, is shown by the analogy between irritation of heat and cold, and that determined by other irritations of moderate intensity. A sea-water bath increases the oxydation processes more than a bath of fresh water. But very violent irritations of sensitive nerves, as by traumatisms or direct application of electricity (Heidenhain), cause a fall of internal temperature, and the same thing happens after section of the spinal cord, or certain lesions of the medulla (Tscheschin). This same section is however followed by an elevation of cutaneous temperature, from paralysis of the vaso-motor nerves (Brown Sequard). The internal and external temperature of the body does not, therefore, always correspond; on the contrary, fever has even been defined by certain authors to essentially consist in the withdrawal of heat from the interior, to be distributed at the periphery. This can only be considered an imperfect statement of the fact, that in fever the elimination of heat from the surface is diminished, as it is when the body is surrounded by an atmosphere approaching its own temperature. Heidenhain has found that irritation of the sciatic nerve produces a greater fall of temperature, when the animal is plunged into a cold bath at the time of the experiment. If fever has been previously induced by the injection of pus, no fall of temperature can be obtained by irritation of the sciatic, unless the animal be in the bath. The author infers that, in health, irritation of the sensitive nerves acts by quickening the circulation on the periphery (stimulating the peristaltic contraction of the small blood-vessels), so that more blood is brought to the surface to be cooled. In fever, where the blood-vessels of the periphery are passively dilated, the blood stagnates instead of circulating, and the heat evolved by destructive metamorphosis of tissue is so great as to annul the effect of radiation. Hence, when the blood is made to circulate more rapidly by irritation of the sciatic, the peripheric parts of the body are so hot that no refrigeration is produced, unless it be brought in contact with the cool medium of the bath. We think that, in this case, the direct stimulation of the vaso-motor nerves of the skin act in concurrence with the reflex central irritations to accelerate the circulation of the surface, and thus favor the cooling of the mass of the blood. Also, that the fall of internal temperature observed after excessive irritations of sensitive nerves in healthy animals, and which contrasts so remarkably with the rise of temperature determined by their moderate stimulation, depends, not only on variations of the peripheric circulation, but much more upon the direct influence exercised on the nutritive oxydation processes by the central nervous organs. A constant influx of nerve force is as essential to these chemical changes, as is the constant influx of electricity to the chemical changes occurring in certain fluids that may have been just created by the passage of a current. If the action, in these respects, of these organs (spinal cord, medulla, or base of brain) be temporarily abolished by a shock to the periphery, the heat-making processes are necessarily interrupted. If this violent irritation abolishes action, the absence of normal irritation or stimulus to the sensitive nerves of the surface, when the temperature of the medium too nearly approaches its own, should be followed by paresis of this same apparatus; and, as we have seen, experiment proves a slackening of nutrition; although, from diminished radiation, there is a slight rise of temperature during exposure to warm air or warm water.

The muscles constitute one of the principal foci for the production of animal heat; and it is very remarkable that paralysis of the motor nerves, resulting either from lesions of the motor centres in the cord, or from injections of woorara, so notably reduce the temperature. In the first case, the reduction is local, confined to the limb to which the nerves affected are distributed; in the second, it is general, and may extend four or five degrees (Riegel.) If the first impression for the modification of temperature is made on the sensitive nerves, the final effect is only obtained when the impression has been transmitted by the motor nerve. Now we know that with paralysis of motor nerves is associated paralysis of secreting glands, which, almost equally with muscles, are under their influence. We are, therefore, perhaps, justified in supposing that the degree of paresis of the nerves that follows elevation of external temperature, diminishes the powers of digestion, not only by slackening nutrition, but by directly lowering the secreting powers of digestive glands in the stomach and intestine.

From these considerations we may understand at least some of the reasons why all digestion is more difficult in summer than in winter, and more so in infants than in adults, from the extreme susceptibility of their nervous system, and their comparatively small capacity for regulating the heat-making processes independent of the surrounding medium. Hence the following rules are of more importance for them:—

Cool the surface by bathing and washing frequently in the course of a hot day. A bath, however, when to be repeated several times a day, must not be of long duration. Let the infant have a drink of plain water now and then, to make up for part of its loss through perspiration; but no extra food, which will be digested but slowly, and in smaller quantities. At all events, see that the practice of putting infants to the breast, when they are scorched by heat and perspiration, is done away with. Breast-milk is their food as well as beverage under normal circumstances. But in the heat of the summer, while less food is digested and required, more water is wanted. You might try to quench your own thirst by a hearty meal just as well as satisfy with milk the thirst of infants crying for water. With this water ought to be mixed, when the season is very hot, a drachm or two, according to age, and divided into small doses, of brandy or whiskey, in the course of twenty-four hours.

There may arise objections to the latter plan; and nearly all the criticisms of the first edition of this essay have been directed against this recommendation. It is said that alcohol is an abnormal and unnatural food for babies. But we do not recommend it as food, but as medicine, to be given with the same precautions as any other strong medicine. While respecting the convictions and appreciating the right to be mistaken of everybody, we claim the administration of alcohol as good practice. In very hot weather the system is no longer normal, a certain degree of debility, of insufficiency, is perceptible in every function. Therein lies the indication for administering a stimulant, partly for its curative, partly for its preservative, effect. Acting on this principle, you would administer quinine to a person exposed to malaria, who has not yet been taken with an attack of chills and fever, but is pale, easily fatigued, and has a slightly swelled spleen.

After all this, Mr. President, if I were called upon to write out a few brief and intelligible rules on the feeding of infants in general, and in special behalf of our tenement population, I should think that a few words will be read and remembered better than a long essay; and, although not every indication can be fulfilled, not every taste suited, I hope these few brief rules may do good to the public at large, as they do in my own practice. They would read as follows:—

I. ABOUT NURSING BABIES.

Overfeeding does more harm than anything else. Nurse a baby of a month or two every two or three hours.

Nurse a baby of six months and over, five times in twenty-four hours, and no more.

When a baby gets thirsty in the meantime, give it a drink of water or barley-water. *No sugar.* In hot weather—but in the hottest days only—mix a few drops of whiskey with either water or food, the whiskey not to exceed a teaspoonful in twenty-four hours.

II. ABOUT FEEDING BABIES.

Boil a teaspoonful of powdered barley, (grind it in a coffee-grinder,) and a gill of water, with a little salt, for fifteen minutes, strain it, and mix it with half as much boiled milk and a lump of white sugar. Give it lukewarm, through a nursing-bottle.

Keep bottle and mouthpiece in a bowl of water when not in use.

Babies of five or six months: half barley-water and half-boiled milk, with salt and white sugar.

Older babies, more milk in proportion.

When babies are very costive, use oatmeal instead of barley. Cook and strain.

When your breast-milk is half enough, change off between breast-milk and food.

In hot summer weather, try the food with a small strip of blue litmus paper. If the blue paper turns red, either make a fresh mess, or add a small pinch of baking-soda to the food.

Infants of six months may have beef tea or beef soup once a day, by itself, or mixed with the other food.

Babies of ten or twelve months may have a crust of bread, and a piece of rare beef to suck.

No child under two years ought to eat at your table. Give no candies; in fact, nothing that is not contained in these rules, without a doctor's order.

III. ABOUT SUMMER COMPLAINT.

It comes from overfeeding, and hot and foul air; never from teething. Keep doors and windows open. Wash your children with cold water at least twice a day, and oftener in the very hot season.

When babies vomit and purge, give nothing to eat or drink for four or six hours, but all the fresh air you can. After that time, you give a few drops of whiskey in a teaspoonful of ice-water every ten minutes, but not more until the doctor comes.

When there is vomiting and purging, give no milk.

Give no laudanum, no paregoric, no soothing syrup, no teas.

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