table gives some idea of the amount of fat contained in a few common foods:

	Per cent. of fat.
Fat tissue of swine	92.21
Fat tissue of beef	88.88
Fat tissue of mutton	87.88
Butter	85.0 to 90.0
Eggs	12.0
Fat meat	5.0 to 12.0
Milk	3.0 to 4.0
Cheese	8.0 to 30.0
Vegetables	0 to 3.0
Nuts	53.0 to 66.0

All animal fats show a remarkable uniformity in elementary composition, containing on an average 76.5 per cent. C, 11.9 per cent. H, and 11.6 per cent. O. The chemical composition of fats indicates the importance of these principles as heat-producing agents. In the carbohydrates and other allied principles, the hydrogen and oxygen are present in such proportion as to form water (starch $C_6H_{10}O_5$), while in the fats, as in tripalmitin ($C_{51}H_{98}O_6$), only twelve atoms out of ninety-eight have their combining equivalent of oxygen contained in the compound, and hence the remaining hydrogen atoms, as well as all of the carbon, are free for oxidation. And since the quantity of heat produced is dependent upon the amount of chemical action or oxidation, it follows "that a given quantity of fat will have the power of appropriating about 2.4 times as much oxygen as the same quantity of starch, or, in other words, will develop about 2.4 times as much heat in the process of oxidation, and hence has about 2.4 times as much value as a heat-producing agent" (Pavy). But while the fats are especially important for the production of heat, and for forming the basis of adipose tissue, they are likewise essential for tissue development generally. The great importance of fat in food and of that deposited in the body is to be found in the aid which it furnishes to the hungry organism in developing its wasted tissue. A purely proteid diet for a person poor in fat necessitates a large amount of the former to sustain the weight of the body, indeed more than the intestines are capable of absorbing. But a mixture of fat with the proteid matter diminishes both the amount of circulating albumin in the body and the proteid metabolism. The proteid food is needed to sustain the bodily wants, and at the same time to prevent the loss of fat. Still, it is not possible to convert a poor body into a body rich in fat and proteid material by a simple albuminous diet; fats or carbohydrates are needed, admixture of which diminishes the work of the organism. The energy of the active cells of the body is then only in part used for the decomposition of albumin, the remaining energy being applied to the decomposition of fatty matter. This is well illustrated by the increased metabolism of fatty matter during muscular exertion. In the words of Voit, "muscular work renders the cells capable of decomposing more material, and, after the use of the disposable albumin, the fat is brought into requisition. Thus nothing is of greater influence upon fat metamorphosis than work." (See *Nutrition*.)

The carbohydrates, being especially found in the vegetable kingdom, belong essentially to a vegetable diet. A few, however, occur in animal food, as glycogen and sugar in the liver, lactose in milk, and the sugar present in small quantities in muscle tissue. In composition, the carbohydrates are all alike in containing hydrogen and oxygen in such proportion as to form water. They may be divided into three main groups, viz.: monosaccharides, including such sugars as dextrose or glucose, which have the formula $C_6H_{12}O_6$; disaccharides, including such bodies as cane sugar, having the formula $C_{12}H_{22}O_{11}$, which break down into two molecules of a monosaccharide; and polysaccharides, as starch and dextrins, having the formula $(C_6H_{10}O_5)_n$. As a class they constitute very easily decomposable material, readily breaking down into carbonic acid and water, and as food stuffs they are especially prominent in causing an accumulation of glycogen in the liver. They are, moreover, without doubt, the source, in part, of the fat in the body. Sugar or starch is always present in fattening foods, and although it is doubtful whether the fat is formed directly from the carbohydrates, still the association of fat and glycogen in the hepatic cells, and the fact that the former is increased by such diets as tend to increase the latter, would naturally suggest a connection between carbohydrates and the production of fat. (For a discussion of this question see *Nutrition*.) Carbohydrates, like the fats, tend to diminish proteid decomposition, and even more decidedly; and as they are likewise able to prevent the withdrawal of fat from the body (according to Voit 175 parts of carbohydrates accomplish as much as 100 parts of fat), it is evident that they possess the power, in a high degree, of taking the rôle of the fats. Moreover, while the carbohydrates are being oxidized, the fat formed from albumin is spared, and Voit[14] considers that in both carnivorous and herbivorous animals the main action of carbohydrate food (so far as its connection with fat is concerned) is to protect the fat already formed, and that in no case does the fat itself have its origin in the carbohydrates, but in the carbon surplus of proteid food (see *Nutrition*). Carbohydrates differ from fats in that they contain, weight for weight, less potential energy than the latter. They differ likewise in being more easily digestible.

Under the head of nitrogenous principles, those classified as proteids or albuminous bodies are by far the most important. Of less importance dietetically are the so-called albuminoids or gelatinous principles, and of still less value are the various nitrogenous extractives, so conspicuous in many foods of animal origin.

The proteid or albuminous and gelatinous principles are all very much alike in general composition, showing, however, some decided differences in their content of nitrogen. Most of the proteid bodies occur in solid form, in both the animal and the vegetable kingdom, though a few are to be found dissolved in the fluids of the organism. Voit[15] has estimated from analyses by Bischoff that in a fully developed human body weighing 68.65 kgm. (151.3 pounds) there would be contained, when dry (at 100° C.), 22.4 per cent. of albuminous matter, and 14.8 per cent. of collagenous tissue. The excretory products of animal organisms contain such a large percentage of nitrogen, it is evident that the nitrogenous principles must play an important part in supplying the needs of the body. Of these the albuminous principles are the most important, and for man and animals albumin, in its various forms, constitutes a vital food stuff, without which life cannot be long sustained. As the content of albuminous or proteid matter in the body is large, and as all the active cells of the body are protoplasmic, it follows that albumin must be supplied in considerable quantity to take the place of that used up in the ordinary processes of life. It is, however, widely distributed through both the animal and vegetable kingdoms; notably in the casein of milk, egg albumen, and myosin of muscle in the animal kingdom, and in the coagulable albumin, vegetable casein, legumin, and congluten of the legumins, and gluten of wheat and rice, etc., in the vegetable kingdom. The albuminous principles, moreover, in view of their containing all of the organic elements necessary to life, are capable, when used in conjunction with the inorganic principles, of supplying alone all the needs of the body; still such a diet would not be an economical one for the system, owing to the large amount of proteid matter which the system would be obliged to work over, together with the subsequent removal of the nitrogen, in order to obtain the requisite amount of carbon. This is easily seen from the composition of pure egg albumin with its 52 per cent. of carbon, when compared with a fat, as tripalmitin with 76 per cent. of carbon, or with a carbohydrate as saccharose with 42 per cent. of carbon and 51 per cent. of oxygen. It is evident, from these figures, that a judicious mixture of an albuminous food stuff with a carbohydrate or fatty food stuff would give a food containing the re-

quired carbon and nitrogen, assimilable with less expense to the body. Liebig's theory, that nitrogenous food is used wholly in building up albuminous tissues, as the muscle and other forms of protoplasm, is now known to be incorrect, and that in reality proteid food stuffs may not only be utilized in the construction and repair of muscular tissue, but may likewise give rise to the storing up of fat. In fact, in the decomposition of proteid matter within the body into the ultimate product, urea, which is excreted, there results a complementary hydrocarbonaceous residue, which can be utilized apparently for the production of heat or other forms of energy. At the same time, the chemically distinct oleaginous and saccharine principles which are together especially concerned, either directly or indirectly, in the production of heat, are likewise of use in the production of other forms of energy, and thus any classification of the alimentary principles based on the physiological grounds originally advanced by Liebig is wholly untenable. It is to be remembered that according to the law of the conservation of energy, the sole cause of animal heat is a chemical process in which food substances are oxidized. The chemical energy of the ingested food manifests itself mainly as heat and motion, and there is no good ground for assuming that the oxidation of proteid may not give rise to heat, as well as the oxidation of fat, etc. Hence, to a certain extent, the two groups of nitrogenous and non-nitrogenous alimentary principles are qualitatively alike, in that both may be concerned in the development of heat and the storing up of fat, although the non-nitrogenous are not distinctly provocative of metabolism. Further, there is no reason why the energy of muscular contraction may not come, in some measure at least, from the decomposition of nitrogenous matter as well as from the oxidation of non-nitrogenous matter. The nitrogenous principles are, however, indispensable to the growth of the tissues of the body, and are likewise indispensable in the production of the nitrogenized enzymes, on the presence of which the digestive juices of the body depend for their special action.

Collagenous tissue, comprising the gelatinous principles (organic basis of bone, cartilage, tendons, and connective tissue), cannot supply the place of the albuminous principles; still, Voit[16] has found that nitrogenous equilibrium is established at a lower level of proteid food when gelatin is added, and Forster[17] apparently considers that in the metabolism of gelatin it rapidly splits up into a urea and a fat moiety, but is unable to imitate the other function of proteid matter, or to take part in the formation of living protoplasm. (For nitrogenous metabolism see *Nutrition*.)

There are a number of crystalline nitrogenous substances, amido-acids and nitrogenous bases, occurring in both the animal and vegetable kingdoms, which are present in greater or less quantity in food, such as creatin and other like proteid decomposition products, contained, for example in some quantity, in Liebig's *extractum carnis;* also the vegetable alkaloids. None of these, however, are of any great value as food; the majority of them pass quickly out of the body, but little if any altered, although one or two, as asparagin,[18] are said to diminish slightly proteid metabolism. The more highly complex lecithin, present in the yolk of the egg, in the brain, etc., may possibly be placed among the true foods, though no direct experiments have been tried to demonstrate its action. It is not improbable, however, that the various amido-acids and nitrogenous bases which are so abundant in animal tissues do have some indirect value as alimentary substances, though they contain little potential energy, and we may reasonably consider that these various nitrogenous extractives have some power, possibly, in influencing the rate of metabolism or in modifying other nutritional processes. The main action of the alkaloidal substances, as the caffeine of coffee, is that of a stimulant, acting especially upon the fatigued nervous system, though many of the common alkaloidal infusions made from roots, leaves, and berries may be somewhat nutritious from the albuminous and fatty matters which they contain, as is the case with cocoa.

The drinks commonly used as food may be divided, aside from water, into the alcoholic, acidulated, saccharine, gaseous, and infusions of various substances, such as tea. The alcoholic drinks contain from forty to sixty per cent. of alcohol, as in rum, brandy, and whiskey, to from two to ten per cent., as in beer and light wines. Malt liquors contain, perhaps, the largest number of constituents, among others there being sugar, dextrin, gluten, and various substances from the hops. The exact value of alcohol as a food, broadly considered, is uncertain. Recent experiments, carefully made on man,[19] however, clearly show that when moderate amounts of alcohol are ingested, the alcohol is burned up in the body—*i.e.*, oxidized like any non-nitrogenous food. The potential energy of the alcohol is transformed into kinetic energy, and consequently alcohol is to be considered as having some food value. It may, therefore, be classified with the non-nitrogenous foods. Further, as a non-nitrogenous food, alcohol may replace an isodynamic amount of fat or carbohydrate in the diet without change in the balance of income and outgo. Alcohol serves to protect body protein and fat from oxidation; *i.e.*, like a typical non-proteid food it diminishes the oxidation of tissue proteid by being itself oxidized. These facts, however, do not imply that alcohol is necessarily a desirable food or that it is physiologically economical. It is to be remembered that, prior to its oxidation in the body, alcohol may produce deleterious effects of various kinds, more than counterbalancing any gain which may result from it oxidation. It may likewise give rise to changes, either directly or indirectly, in the various metabolic processes of the body, which must of necessity influence more or less its value as a food. Alcohol has a direct and an indirect influence upon the secretion of gastric juice.[20] In this direction it acts as a stimulant. It likewise stimulates the secretion of saliva.[21]

Food, as eaten by man and animals, is a natural mixture of the various alimentary principles described. Seldom are the isolated principles eaten by themselves, other than in the case of sugar and salt, or pure fat. It is the function of digestion to separate the individual principles from this natural mixture, by which means they are separately absorbed. The behavior of animal and vegetable food is quite different in the alimentary canal, which difference is dependent more upon the quality of dry substance contained in the latter food than upon its quantity. Vegetable food yields a much larger percentage of indigestible residue, and is in itself much less easily digestible, owing to the fact that it is more or less enclosed in the difficultly soluble cellulose, while animal food is free. Moreover, vegetable food, as a rule, is less easily absorbed, and, as it contains usually a less percentage of nitrogen, a much larger quantity is needed to furnish a certain amount of this element than in the case of animal food. Again, the large quantities of starch contained in a vegetable diet tend to produce an acid fermentation in the small intestines, with formation of butyric acid, together with marsh gas and hydrogen, which causes the frequent intestinal excretions of herbivorous animals.

In a determination of the food value of a given food stuff, or of a given diet composed of a mixture of food stuffs, it is necessary to ascertain its chemical composition with special reference to the content of proteid, fat, carbohydrate, and inorganic salts; its caloric or heat value; and lastly its digestibility or availability. In an ordinary mixed diet, proteid matter is usually present in the proportion of one part to about five parts of non-proteid matter—*i.e.*, fats and carbohydrates. The proportion of fat to carbohydrate is usually exceedingly variable, ranging anywhere from one part of fat to from five to twelve parts of carbohydrate. While these statements are to be accepted as a general expression of the ordinary proportion of the three primary varieties of food stuffs contained in an average diet, it is to be remembered that the element of cost or the ease of procuring frequently determines the relative amount of the three classes of food stuffs in the daily diet. Thus, in countries where meat is plentiful, as in South America, proteid food is consumed in much larger proportion than above, whereas in some Asiatic countries, the prevalence of rice, cereals, and fruits leads to a daily diet in which non-proteid foods are especially conspicuous, and the proportion of proteid is reduced to the minimum necessary for life. Further, for similar reasons, the ratio of fat to carbohydrate undergoes wide variation among different races or in different countries. Thus, in the far north, fat (animal) constitutes the greater proportion of the non-proteid part of the diet, while in countries where cereals abound, carbohydrates, mainly in the form of starch, make up the greater portion of the non-nitrogenous food.

For the ordinary purposes of food analysis, the amount of proteid present is usually ascertained by determining the content of nitrogen, and multiplying this figure by the empirical factor 6.25, on the assumption that proteids contain on an average 16 per cent. of nitrogen. In recognition of the fact that the value so obtained is not always an accurate measure of the amount of true proteid present, the word "*protein*" is employed as an arbitrary term to designate a group assumed to include all the nitrogenous matter of the food except the nitrogenous fats. True proteids contain 15 to 17 per cent. of nitrogen and 50 to 54 per cent. of carbon. It is very difficult, however, to determine accurately the amount of true proteid in a mixture, and so chemists are practically forced to rely upon the content of nitrogen as a measure of the amount of proteid present. The above variation in the percentage of nitrogen in different proteids, however, introduces a possible error when the nitrogen content is multiplied by 6.25. This error is probably less, however, than that which comes from the fact that in some food stuffs, as in meat for example, there is a certain amount of nitrogen in the form of amido-acids, etc. Still, even here the error is probably not very great. Thus, beef entirely freed from fat contains, when dried, 49.6 per cent. of carbon, 15.3 per cent. of nitrogen, and 5.2 per cent. of ash.[22] While protein is thus seen to be not strictly equivalent to proteid, yet the content of so-called protein gives, as a rule, a fair measure of the amount of true proteid present. In special cases, however, it is necessary to make use of more elaborate methods of analysis, and to differentiate between the nitrogen of proteid and the nitrogen of amids and amido-acids, etc.

Under the head of fats is included the total ether extract of the food. This is ordinarily made up of neutral fats, but free fatty acids are sometimes present, likewise such phosphorized fats as lecithin and protagon, and also bodies like cholesterin and pigments.

Carbohydrates are usually determined by difference, after the ash and water have been estimated, although frequently starch, sugar, and cellulose are determined separately by direct analysis.

Equally important with chemical composition is the determination of the heat value of food stuffs. This is done by multiplying the number of grams of proteid, fat, or carbohydrate by a number, ascertained by direct experiment, representing the amount of heat produced by the oxidation of 1 gm. of the fat, carbohydrate, or proteid, to water and carbonic acid and to urea. Taking the calorimetric observations of Rubner as a standard, it is found that 1 gm. of proteid on an average, when oxidized to urea, yields 4,124 calories or gram degrees of heat (small calories), or 4.1 kgm. degrees (large calories). Similarly 1 gm. of fat, oxidized to carbonic acid and water, yields 9,321 gm. degrees of heat (small calories), or 9.3 kgm. degrees (large calories), while 1 gm. of carbohydrate, as starch, yields 4,116 small calories, or 4.1 kgm. degrees of heat.

The following table gives the percentage composition of a few common foods, together with the heat values expressed in the form of kilogram degrees of heat (large calories) per pound.

	Water, per cent.	Protein, per cent.	Fat, per cent.	Carbohydrate, per cent.	Ash, per cent.	Heat value per pound, calories.
Lean beef, fresh loin	58.2	17.1	11.1	....	0.9	785
Beef, loin, very fat	44.9	16.0	29.1	....	0.8	1,525
Canned boiled beef.	51.8	25.5	22.5	....	1.3	1,425
Lean breast of veal, fresh	53.3	16.1	4.3	....	0.9	480
Salmon, fresh	40.9	15.3	8.9	....	0.9	660
Codfish, fresh, steaks	72.4	17.0	0.5	....	1.0	335
Oysters, solid	88.3	6.0	1.3	3.3	1.1	230
Hen's eggs, uncooked	73 7	13.4	10.5	....	1.0	720
Butter	11.0	1.0	85.0	....	3.0	3,605
Cheese, American, pale	31.6	28.8	35.9	....	3.4	2,055
Milk	87.0	3.3	4.0	5.0	0.7	325
Hominy, uncooked	11.8	8.3	0.6	79.0	0.3	1,650
Oatmeal "	7.3	16.1	7.2	67.5	1.9	1,860
Wheat flour, entire wheat	11.4	13.8	1.9	71.9	1.0	1,675
White bread, Vienna	34.2	9.4	1.2	54.1	1.1	1,230
Lima beans, fresh	68.5	7.1	0.7	22.0	1.7	570
Fresh beets	87.5	1.6	0.1	9.7	1.1	215
Potatoes, raw	78.3	2.2	0.1	18.4	1.0	384
Sweet potatoes, raw	69.0	1.8	0.7	27.4	1.1	570
Green peas	74.6	7.0	0.5	16.9	1.0	465
Apples	84.6	0.4	0.5	14.2	0.3	290
Bananas, yellow	75.3	1.3	0.6	22.0	0.8	460
Oranges	86.9	0.8	0.2	11.6	0.5	240
Strawberries	90.4	1.0	0.6	7.4	0.6	180

Taken from Atwater and Bryant, Bulletin No. 28, Revised. United States Department of Agriculture.

As to the amount of food required by an adult during twenty-four hours, much depends upon the condition of the body, and especially upon the amount of muscular work being done. Voit, in Germany, has given for a man of 150 pounds body weight, doing ten hours of muscular work, the following diet as requisite:

105 gm. assimilated proteid	× 4.1 =	430 large calories.
56 " fat	× 9.3 =	520 " "
500 " carbohydrate	× 4.1 =	2,050 " "
		3,000 " "

Atwater,[23] in this country, from a large number of observations, considers a somewhat more liberal allowance of proteid desirable, and a little larger heat value for a man doing severe muscular labor; say 125 gm. proteid and a total heat value of 3,500 large calories. Laying aside minor points of variation, it is safe to assume that a healthy workingman, of average body weight, requires in his daily diet at least 100 gm. of pure proteid, together with sufficient fat and carbohydrate to give a heat value of 3,000 large calories. No doubt, a man can maintain himself in perfect health on a somewhat smaller allowance of proteid, but in order to do this he must increase very greatly the amount of non-proteid food taken, especially carbohydrates.

Taking the above diet of Voit's, and assuming that in order to obtain the 105 gm. of assimilable proteid 118 gm. of proteid food would be required, we find that this means a daily consumption of 18.03 gm. of nitrogen and at least 328 gm. of carbon. Further, since the 118 gm. of albumin contain but 63 gm. of carbon, it is plain that there would be required 265 gm. of carbon, in the form of fats or carbohydrates.[24] The following table gives the number of grams of several common foods necessary to furnish the daily requisite of carbon and nitrogen:

For 18.3 Gm. Nitrogen.	Gm.	For 328 Gm. Carbon.	Gm.
Lean meat	538	Lard	450
Wheat flour	796	Corn	801
Eggs (18)	905	Wheat flour	824
Corn	989	Rice	899
Rice	1,868	Eggs (43)	2,231
Milk	2,905	Lean meat	2,620
Potatoes	4,575	Potatoes	3,124
Lard	4,796	Milk	4,652

It is thus evident that no one of these substances is in itself a proper food. Lean meat, for example, must have added to it fat or carbohydrate, or both; while potatoes,

as an example of a carbonaceous food, require an admixture of nitrogenous matter. Hence a judicious mixture of all the alimentary principles from both the animal and vegetable kingdoms constitutes the food best adapted to the wants of mankind. Finally, emphasis must be laid upon the great difference in heat value between fats on the one hand, and proteids and carbohydrates on the other; fats having per gram a heat value more than twice that of proteids or carbohydrates.

R. H. Chittenden.

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2 Hoppe-Seyler: Physiologische Chemie, p. 28.
3 Hermann's Handbuch der Physiologie, vi., 347.
4 Philosophical Transactions, 2, 494.
5 Zeitschrift für Biologie, ix., 387.
6 Aronstein: Pflüger's Archiv für Physiologie, viii., p. 75. Alex. Schmidt: Pflüger's Archiv, xi., p. 1.
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8 Weiske: Zeitschrift für Biologie, vol. vii., pp. 179 and 333.
9 Forster: Zeitschrift für Biologie, vol. xii., p. 464.
10 Comptes Rendus, 1872, 64, p. 1353.
11 Compare Homburger: Zeitschrift für physiolog. Chem., vol. ii., 191.
12 Bunge: Zeitschrift physiol. Chem., ix., p. 49.
13 Bunge: Lehrbuch d. physiol. u. pathol. Chem., 1889, p. 100.
14 Hermann's Handbuch der Physiologie, vi., 260.
15 Ibid., vi., 388
16 Zeitschrift für Biologie, viii., 297.
17 Text-Book of Physiology, p. 467.
18 Zeitschrift für Biologie, xv., 261.
19 Atwater and Benedict: Bulletin 69, United States Department of Agriculture.
20 Chittenden, Mendel, and Jackson: Amer. Journ. Physiol., i., p. 164.
21 Chittenden and Richards: Amer. Journ. Physiol., i., p. 471.
22 Argutinsky: Pflüger's Archiv f. Physiol., lv., p. 345
23 See Atwater and Woods: Bulletin No. 46, United States Department of Agriculture, p. 63.
24 Voit: Hermann's Handbuch der Physiologie, vi., 497.

ALIMENTARY TRACT.—DEVELOPMENT.—The alimentary tract arises from the inner germ layer, reinforced by the visceral layer of the middle germ layer. The inner germ layer furnishes the epithelium of the entire alimentary tract and its accessory organs, the lungs, liver, pancreas, etc. The visceral layer of the middle germ layer, on the other hand, gives origin to all the muscles and connective-tissue layers, and also to the mesentery and omentum. By a process of folding there is gradually formed a tube which at first is broadly in contact with the dorsal wall of the embryo along its entire length immediately ventrad to the notochord. In this tube we can distinguish three divisions, which have received the names of fore, mid, and hind gut. Neither the fore gut nor the hind gut opens to the exterior at first; they end blindly. During the earlier stages of development the mid gut is connected with the yolk sac (Fig. 69), by a wide communication, but as development progresses this communication becomes more and more constricted. This constriction is brought about by

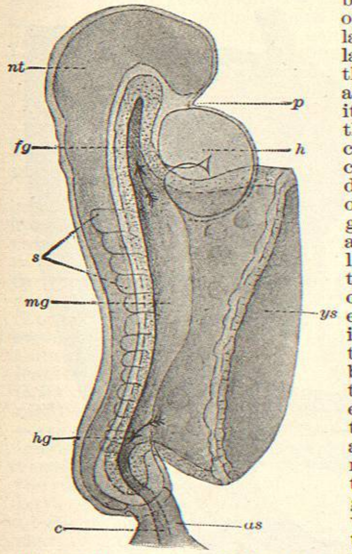

FIG. 69.—Human Embryo, 2.5 Mm. Long. × 30. (After Kollman.) The yolk sac is cut away. The rudiment of the primitive intestines can be seen extending through the embryo. *as*, Allantois stalk; *c*, epithelial tube within the allantois stalk; *fg*, fore gut; *h*, heart; *hg*, hind gut; *mg*, mid gut; *nt*, neural tube; *p*, mouth pit; *s*, somites; *ys*, yolk sac.

the growth caudad, on the one hand, of the fold which gave rise to the fore gut, and on the other hand by the growth cephalad of the fold which formed the hind gut.

By this growth in both directions the previously wide

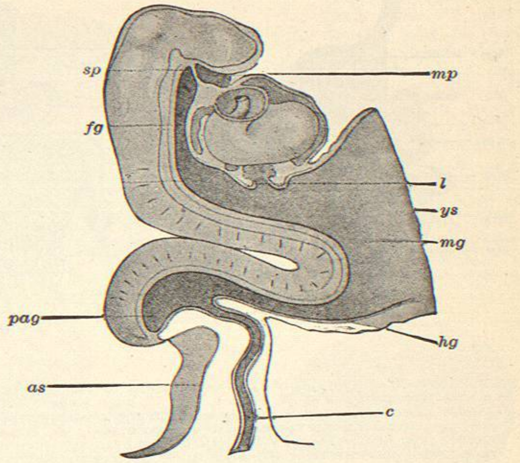

FIG. 70.—Human Embryo, 4.10 Mm. Long. (After His.) *as*, Allantois stalk; *c*, epithelial tube within the allantois stalk; *fg*, fore gut; *hg*, hind gut; *l*, rudiment of the liver; *mg*, mid gut; *mp*, mouth pit; *pag*, post-anal gut; *sp*, Seessel's pocket; *ys*, yolk sac.

communication of the mid gut with the yolk sac becomes smaller and smaller, until finally there remains only a narrow communication between the mid gut and yolk sac—the vitelline duct or *ductus omphalo-entericus*.

On the ventral side of the fore gut the heart is situated, while from the hind gut a diverticulum grows out which

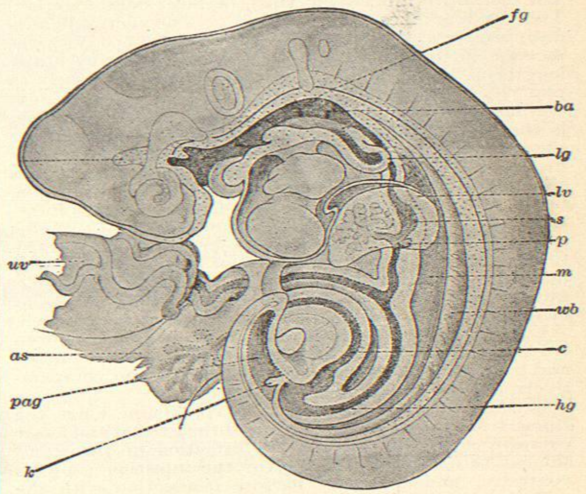

FIG. 71.—Human Embryo, 5 Mm. Long. Sagittal section of a reconstruction. × 15. (After His.) *as*, Allantois stalk; *ba*, branchial arches; *c*, allantois canal; *fg*, fore gut; *hg*, hind gut; *k*, kidney; *lg*, lung; *lv*, liver; *m*, mesentery; *p*, pancreas; *pag*, post-anal gut; *s*, stomach; *uv*, umbilical vesicle; *wb*, Wolffian body.

forms a thick-walled stalk. This stalk is known as the allantoic stalk, or the *Bauchstiel* of His. In man and other primates this diverticulum always remains narrow, but in the lower vertebrates it forms a free vesicle.