est one, D, which is the battery, being at the other end; the others being arranged intermediately.

At the end of the defecator there is a trough, E, for the reception of the scum gathered from the juice in the defecator. In the lower part of the partition, between the defecator and the pan, B, there is a slide valve, *x*, which may be opened to allow the juice to be discharged from the defecator into the pan, B.

Steam is furnished to the evaporating pipes, *c c c*, within the several pans, by branches from the main pipe, F, which leads it from the boilers. Cocks or stop valves, G, are fitted to the steam pipes so that the steam can be shut off from either pan without interfering with the others. The water from the condensation of the steam in the several pans is carried back to the boilers by the pipe, H. In the battery is a discharge cock or valve, *d*. J is the strike box.

Rotary pumps, *a a′ a″*, for passing the juice forward from one pan to another of the series, as the process advances, are arranged one under each of the divisions between the pans, A B C D: the discharge pipe from each pump leads forward to the next pan in the series, so that the contents of the defecator, A, may be discharged into B, those of B, into C, and those of C, into the battery, D.

Motion is communicated to these pumps by belts on the pulley, *e*, and the loose friction pulleys on the rods operated by the handles, *b b b*.

The operation of the train and treatment of the juice are as follows:—

In starting, the defecator, A, is charged with raw juice from the mill or juice boxes; the steam is let on, and when the juice has attained a temperature of about 150° Fah. the proper dose of lime for its defecation is added. As the heat of the juice increases, the albuminous matters rise to the top with many impurities in the form of scum, which is skimmed back into the trough, E, and there allowed to settle.

As soon as the juice has been properly defecated, the slide valve, *x*, is opened and the defecated juice allowed to run into pan, B, until the proper quantity is obtained, when the said valve is closed. Steam is then let on to pan, B, and the boiling and cleansing process begins therein and the impurities, as they rise, are brushed back into the defecator, and from thence into the trough, E. After the juice has been boiled a short time in the pan, B, it is discharged by means of the pump, *a′*, into the pan, C, and the pan, B, is replenished from the defecator, either through the slide valve, *x*, or the pump, *a*. Steam being then let on to the pan, C, the cleansing process proceeds therein as it previously did in B. As the juice in the pan, C, becomes thick and viscid, and does not readily throw off its impurities, a sufficient quantity of less concentrated juice is passed forward to it from the pan, B, and ebullition is increased and the cleansing proceeds again actively. The impurities as they rise in C, are brushed back to the pan, B, and from thence to the defecator, and thence to the trough, E.

When the juice has been properly cleansed of its mucilage and other impurities in the pan, C, it is passed forward to the battery, D, by the pump, *a″*, where it is concentrated to the sugar point, and whence it is discharged by a cock or valve, *d*, in the bottom, into the strike box, J. As soon as the sugar in the battery has been discharged into the strike box, the battery is recharged with sirup from the pan, C, by the pump, *a″*, and that pan replenished from the pan, B, by the pump, *a′*; from the defecator, A, by the pump, *a*, or valve, *x*; and the defecator, as soon as it is completely emptied, *and not before*, is again supplied from the juice box or mill, and thus the rotation is continued, the pans, A B and C, clarifying and preparing the juice for the battery, D.

It will be observed that in the process performed by this apparatus, the proper point of liming can always be maintained, from the fact that the whole of the juice so defecated in the defecator, A, is passed forward into the other pans of the series in succession, without any admixture with the raw juice, consequently giving to the sugar maker the means and facility of keeping an uniform temper in the cane juice from the beginning to the end of the crop; and from the defecator to the battery, the cane juice is treated continuously as a boiling mass, whereby a perfect separation of the albuminous principle can always be maintained before the sirup is concentrated to the sugar point in the battery, and hence are obviated the imperfect defecation caused by the too high liming of the juice, as in the ordinary fire or kettle train, and the imperfect clarification and cleansing of the juice, as in the isolated pans of the ordinary open steam train; as the result of this process, the finest quality of brown sugar that can be made is obtained.

Besides the improved result thus obtained by its use, there are other advantages in the working of the connected steam train, to wit: Its management is so extremely simple that *one-half* the attendants required to work other apparatuses are, in this arrangement, dispensed with; the duties of the attendants are rendered very light, for the labor of bucketting is dispensed with, and by "foaming" the pans but little brushing is needed to cleanse the juice completely.

Constant intercommunication can be kept up between the pans, and the juice can be thrown at will from one pan to another, to facilitate the cleansing, as it becomes thick and viscid.

The operation of the train can be expedited or retarded at pleasure, as it is always under the complete control of the sugar maker.

The connected steam train also economizes both time and fuel, it being evident that the necessary manipulation from one pan to another can be performed more expeditiously, and the loss of heat which attends the process in other apparatuses is obviated.

A crop of 515 hogsheads of sugar, made upon the principles embraced in this invention, classed as "choice"—the highest grade of brown sugar known in the New Orleans market, and commanding the highest price.

A working model of this train was exhibited at the Louisiana Industrial Fair, held at Baton Rouge in March last, where a certificate was awarded it "as possessing great facilities for making sugar, and having advantages over any other on exhibition and worthy a first premium."

Three sizes of these trains are manufactured, of the capacity to make 10, 15, and 20 hogsheads of sugar each, per day. As these trains are simple in construction, dispensing with the use of isolated clarifiers, settling tanks, bone black, vacuum pans, centrifugals, and other expensive paraphernalia heretofore required in connection with the ordinary train, they can be furnished to planters at very reasonable prices.

Messrs. Merrick & Sons, Philadelphia, are the authorized agents and manufacturers, to whom inquiries for information can be directed to their office, No. 36 Campstreet, New Orleans, or to either of the patentees.

The patent for this invention was granted to W. H. Gilbert, of Bayou Goula, and H. O. Ames, of New Orleans, La., on June 5th, 1860, through the Scientific American Patent Agency.

CHLORINE.

The value of chlorine to arts and manufactures rests principally upon its power to bleach or destroy color; and by its means, the manufacture of linen and cotton goods has been very much improved.

Chlorine was discovered by the celebrated Charles William Scheele, a Swedish chemist, during the latter part of the last century. Chlorine is so energetic that, if let loose upon the world, it is sure very quickly to unite with some one body or another; hence we never find it on the face of the earth in its primitive condition. Again, nearly all the compounds of chlorine are soluble in water; hence rain dissolves them out of the soil, and thus they pass by running streams, brooks and rivers into the sea, where they are found in great abundance.

The most notable compound of chlorine is the table salt of domestic use, which consists of 23 parts of a beautiful soft metal, called sodium, and 35 parts of chlorine, both of which can be separated from one another, and exhibited in their natural beauty. When chlorine is isolated, it takes the form of a vaporous gas, having a greenish yellow color; hence Sir Humphrey Davy gave it the name of chlorine, from the word *chloros*—light green.

A compound of chlorine and potash is most extensively used in the formation of friction matches. How much these household trifles add to our daily comfort all can tell.

In crowded hospitals, in dark and dank places, where the matter of infectious miasma lurks, a little chlorine set free destroys the arch enemy on his own ground; hence chlorine is a most powerful disinfectant, and for this important discovery Dr. Carmichael Smith received from the English Parliament a large grant of money.

Chlorine gas is extracted from common salt thus: Place into a retort two ounces of salt, one and a half ounce of black oxyd of manganese, two and a half ounces of water; shake these together; then add gradually one and a quarter ounce of concentrated sulphuric acid, and boil the mixture with a gentle heat, and collect the chlorine gas that is generated in a jar over a pneumatic trough filled with warm water. In this state it has a suffocating color, and is very irritating to the trachea or throat valve; thus, wherever it is made, good ventilation is necessary.

There are many other compounds of chlorine used in chemical arts besides those named, such as hydrochloric acid, which consists of hydrogen and chlorine, and being mixed with nitric acid dissolves gold. It also enters into the manufacture of medicines, particularly of calomel. Thus have we shown briefly some of the uses of chlorine. It is but one, however, of a family of four similar bodies, all of which are to be found in the ocean.

SEPTIMUS PIESSE.

GREAT CHURCHES.

The following is a table of the capacity of several large European churches, in which a square yard is allowed for four persons:—

	Persons.	Sq. yards.
St. Peter's, Rome	54,000	13,500
Milan Cathedral	37,000	9,250
St. Paul's, Rome	82,000	8,000
St. Paul's, London	25,600	6,400
St. Petronio, Bologna	24,400	6,100
Florence Cathedral	24,300	6,075
Antwerp Cathedral	24,000	6,000
St. Sophia's, Constantinople	23,000	5,750
St. John Lateran	22,900	5,725
Notre Dame, Paris	21,000	5,250
Pisa Cathedral	13,000	3,250
St. Stephen's, Vienna	12,400	3,100
St. Dominic's, Bologna	12,000	3,000
St. Peter's, Bologna	11,400	2,850
Cathedral of Sienna	11,000	2,750
St. Mark's, Venice	7,000	1,750

The piazza of St. Peter's, in its widest limits, allowing twelve persons to the square yard, holds 624,000; allowing four to the same, drawn up in military array, 202,000.

CELL LIFE.

[Prepared expressly for the Scientific American.]

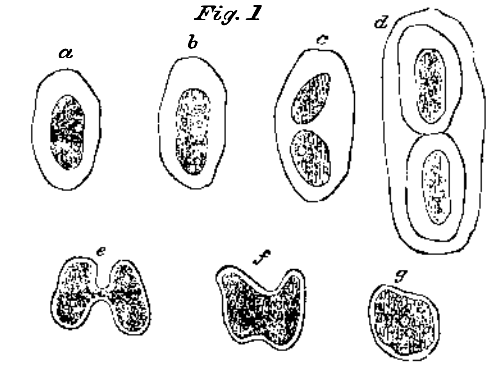
Nature has taken upon herself so many and such varied forms, that it will be a rather startling assertion to unscientific readers to learn that all these, either as animals; from man down to the monad; or as vegetables, from an oak tree to a confervoid, are derivable from, and make their first appearance as, a minute mass of matter of a somewhat spherical form, and termed a cell.

If we are ever destined to solve the great problem to know what is life, it will undoubtedly be on the border land of Nature, where her two great kingdoms of animal and vegetable existence seem to approach each other—that there we shall make the first footsteps which shall eventually lead to the nearest relation to supreme wisdom that man shall be ever permitted to attain. It is this feeling, acknowledged or unacknowledged, that has ever acted as the spur to the investigating mind o the naturalist, and it is the knowledge of the existence of the power of learning that has secured for the patient student of Nature the respect of unscientific minds, and persons who could see no direct advantage to be gained from his painstaking search after that philosopher's stone of life which would make him feel that "knowledge is power." Perhaps no class of phenomena has excited a greater wonder, a purer joy, a sublimer interest among those who have been permitted even to catch a glimpse of them than the almost boundless field of discoveries which are revealed to us by the aid of the microscope, and the interest which they engender is due in no small degree to the fact, that they alone hold out any promise of ever leading us to a knowledge of the *beginning of life*.

We intend herein to give a comprehensive sketch of the primary forms of life in the vegetable and the animal, and any statements given may be implicitly relied on as being in accordance with the very latest developments of the microscope as applied to natural science.

The first indication of life, be it animal or vegetable, is found in the simple cell—a somewhat spherical sac, varying in size, but mostly so small as to be invisible to the unassisted vision, but which, when examined by means of the microscope, is found to have undeviating characters. Yet, strange to say, in this simple form the vegetable cannot be distinguished from the animal. The lower orders of both kingdoms, consisting of single celled organizations, are so similar in outward appearances

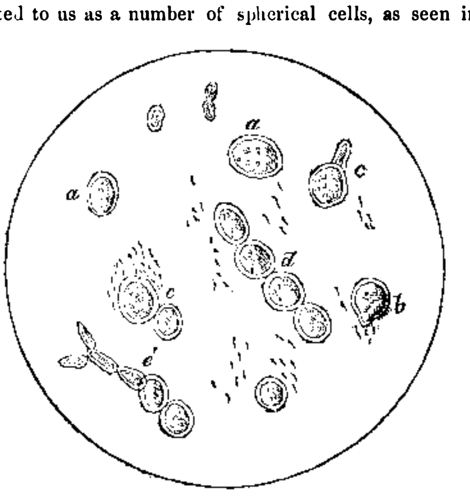
Fig. 1



that they have been often confounded, so that what were once considered whole familes of animals, principally on account of their possessing individual motion, have been now found to be but different states of plants of larger growth.

As a simple example of a single celled plant, we may take the green slime which is sometimes seen spread over damp stones, walls, &c. If a small portion of this be examined under a microscope, it will be found to be composed of a multitude of green cells, each surrounded by a gelatinous envelope, *a*. After a while these are found to become elongated, and at last a contraction is found to take place across the middle portion, *b c d*. This goes on until, at last, each cell becomes two, thus presenting us with a good example of that curious multiplication by duplicative sub-division, which is the mode in which increase nearly always takes place throughout the vegetable kingdom. This is the mode of growth of this plant, but its generation is totally different, yet, at the same time, equally simple. It consists in the union or fusion of two cells—a process which is termed conjugation, and takes place in many other plants. This process is seen in the figure *e f g*. A bridge is first formed between two adjacent cells, which at last coalesce into one large cell. The contents of this then become pasty and sub-divide into new cells.

This plant does not present to us the motile form which is seen in many plants, but our friend the yeast plant shows it in a striking manner. This is first presented to us as a number of spherical cells, as seen in



the figure *a a*. After some time a swelling is seen to take place on one side of the cell, where an opaque spot, called a nucleus, is seen, *b*, and as this growth is continued, there is formed a kind of bud, as shown at *c*. When this bud becomes of the size and form of the parent cell it also pushes out a bud, and the process continuing, a row of cells is formed, as at *d*. The number of these cells in a chain varies as does the size and form of each individual cell. Each one is found to have, somewhere on its wall, the small spot mentioned above, and called the nucleus, which is the starting point for the new cell; and if two of these nuclei are present, as is sometimes the case, two new cells are simultaneously formed, springing from the first or *sporule* stage.

Up to this point the sugar or nitrogenous matter in the liquid undergoing fermentation is being metamorphised into new *matter*—alcohol, carbonic acid and water. To make this clearly apparent we may express it by the use of chemical symbols, as follows. Sugar is composed of twenty-four atoms of carbon, twenty-eight of hydrogen and twenty-eight of oxygen, and is written thus, $C_{34}\ H_{28}\ O_{28}$. The change which takes place during fermentation is thus shown:—

One atom of sugar, $C_{24}\ H_{28}\ O_{28}$, becomes

$C_{16}\ H_{24}\ O_8$ = four atoms of alcohol.

$C_8\ \ O_{16}$ = eight atoms of carbonic acid.

$H_4\ O_4$ = four atoms of water.

So that when we find the yeast plant about to pass from its first into its second stage, we may be sure that fermentation is complete. Brewers being aware of this fact, and having no further use for the plant, arrest its growth at this point by raising the temperature of the liquid.

The second or *thallus* stage makes its appearance after

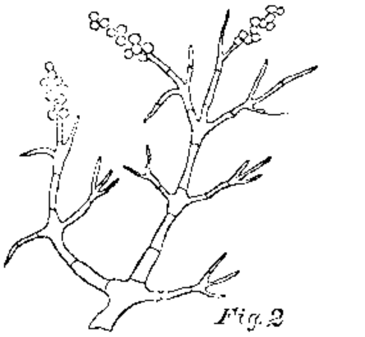
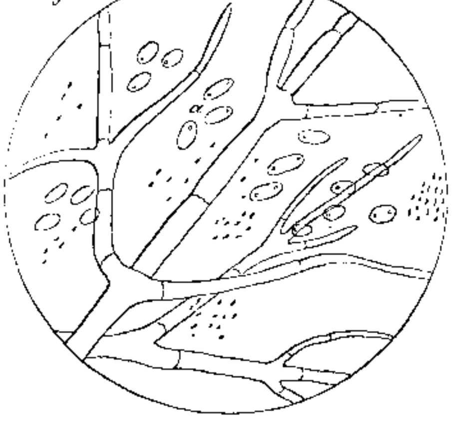


Fig. 2

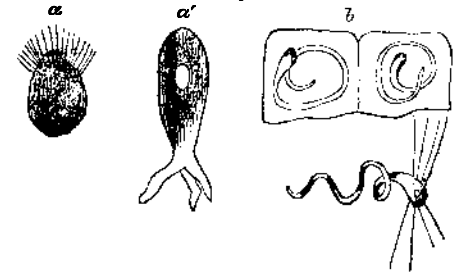
a few days, under favorable circumstances. The cells or sporules become much elongated. A division or partition forms across each, so that two cells are now formed from one and (this process of sub-division continuing) jointed threads make their appearance—at first simple and undivided, and afterwards branched—and the plant now exists in the state of a root or *thallus*. This takes place at or near the surface of the liquid in which it is growing.

Fig. 3.



The yeast plant has up to this point been growing; it now begins to reproduce. The third or *fructification* stage is never seen in fermented liquors, from the reason we have given above. Indeed, it had hardly been seen until Hassall experimented on the yeast plant. When it begins to appear, jointed threads shoot up from the root and become branched; each branch at last bearing upon its extremity a row of rounded and beaded corpuscles, which are about the size of, or perhaps mostly a little larger than, the sporules seen during the first stage, but differ from those bodies by becoming, after a time, opaque and firm in texture. This portion of the life of the yeast plant is somewhat obscure; but it would seem that from some of these corpuscles come forth the seeds, which cannot fructify and grow until they have been impregnated by the antherozoids, which are ejected from other cells. This mode of reproduction has not been positively ascertained to take place in the yeast plant, but it has been seen in nearly allied vegetables. In the figure, the cells containing the seed are seen at *a*, whilst the antherozoids are represented at *b*. These little antherozoids are remarkable from possessing separate individual motion, swimming about vigorously by means of certain hair-like organs attached to one end; and this motion seems so plainly to indicate separate life that they have again and again been taken for animals. The yeast plant is not the only vegetable which exhibits them, but during their fructification they make their appearance in many others, always possess much the same characters, being spiral threads furnished with one or more hair-like appendages, termed *cilia*, as motatory organs. The seeds, or spores, as they are sometimes called, have often motion almost as vigorous as the antherozoids, and produced in the same manner. In Fig. 4 are shown both these organs

Fig. 4.

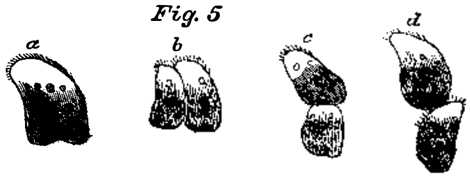


as seen in a larger water plant, *a* being the spore in motion, *a'* the same at rest; *b* the antherozoids in the cells of the plant, and *b'* the same free and in motion.

We can easily understand from the above description of the yeast plant how, from a single cell, may be formed a large, many-branched plant or tree; such an organism being but an accumulation of cells of different forms and structure, as any one can satisfy himself by a careful examination of any vegetable tissue by means of a microscope. But there are other single celled organisms which differ completely in their characters from vegetables, and it is often difficult to distinguish them therefrom. It is only from a careful study of their habits and life that we are enabled to rank them with animals. There are many large and widely distributed groups of organisms which have at different times been bandied backwards and forwards between the vegetable and animal kingdoms; it is but the other day that a large group of what have been hitherto considered distinct plants have been placed by a French naturalist in the animal kingdom.

A good example of a single celled animal is found in one of the little masses of flesh which are so common in stagnant and other water. It is called *chilodon cucullulus*, and its reproduction is effected in a curious manner; very much after the mode of that of the green spoken of above. The animal moves about in the water by

Fig. 5



means of cilliæ placed at one extremity of its body. When reproduction takes place the body sub-divides either longitudinally, *a* and *b*, or transversely, *c* and *d*, each half becoming a separate and complete animal. This operation is performed with such rapidity, under favorable circumstances, that, according to the calculation of Professor Ehrenberg, no fewer than 268 millions might be produced in a month by this repeated act of sub-division.

Thus we see that sub-division of cells constitutes the mode of growth in the lower orders of animals, and the same rule holds good in higher orders; there being this striking resemblance between the two kingdoms. In animals, however, the primary cell form becomes more effectually obliterated than in the larger plants, the larger vessels and some of the tissues not presenting the cell in as perfect a condition as in the plant.

The microscope has been of great service in the study of lower as well as the higher order of animals, and out of its application to the study of the latter has grown a science—that of histology—of infinite value to the anatomist and the medical man, and thus to all mankind.

A. M. E.