

below the plane of the ecliptic; the smooth curve, including the dates February 12 to June 3, is above that plane. The inclination of the comet's orbit to the ecliptic being about 18 deg., the reader must think of that part of the diagram as being tilted out of the plane of the paper, revolved about the line of nodes through the angle 18 deg., so that the point marked May 2 would be about the highest point of the curve. Now imagine the earth to be moving in the plane of the paper and the comet in the tilted curve, and to pass the perihelion point (marked May 10 in the diagram) about April 1. It takes the comet about 40 days to pass from its perihelion out to the earth's distance from the sun, so that it would reach the nearest point to the earth's path about May 11 and during the first half of May the two bodies would be relatively close together; the nearest approach that could occur would be about May 4, when the comet, if it were directly below the earth, would be roughly 6,000,000 miles away. A few days' change in the date of perihelion would here produce a very great change in the comet's apparent course through the heavens. If perihelion should be a few days before the first of April, the comet would cross in front of the earth and so be seen in parts of the sky far from the sun when nearest the earth. In 1759 the passage occurred too early and in 1145 too late, if the date be correct, for the most magnificent effect.

For the perihelion passages in June and July it will be noticed that the comet is nearest the earth just after or close to the time of perihelion when the tail has its greatest development, and also when the comet is near its highest elevation above the ecliptic, so that even when in conjunction with the sun it is so far north as to be visible both evening and morning. In 1456 it was for a time circumpolar so that it could be seen above the northern horizon all night.

In August, September, and October the conditions are even better so far as position in the sky is concerned but the nearest approach to the earth occurs before the greatest development of the tail has been reached. For a November perihelion, especially in the latter part of the month, the favorable position of the comet in the sky during October largely offsets the lack of development of the tail, and so the apparition in 1835 was a favorable one. Had the comet passed the earth two weeks later than it did its distance on October 20 would have been only 15,000,000 miles and its tail might have appeared much larger than it did.

Now as to the 1910 apparition. The comet is now out between the orbits of Jupiter and Saturn. It will be within the distance of Jupiter's orbit after March 1, 1909. It is possible that some one with the aid of a great telescope or a photographic camera may catch sight of the expected visitor during the winter of 1908-09. We may begin to search for it as early as September, 1908, provided good ephemerides are at hand. Almost certainly it may be found by September or October, 1909. It will then be only a round nebula, whatever tail it has being almost directly behind it as seen from the earth. If the date of perihelion should be May 10, the comet will be lost behind the sun in the early part of April, reappearing in the morning sky about the first day of May. It should reach its greatest brilliancy in the last days of May but the morning dawn will prevent its having the most striking effect. It will pass between the earth and the sun about June 1 and there is a possibility then of the tail extending so far out over the earth that it may be very conspicuous in spite of the deep twilight in which the head of the comet must be observed. After June first the comet should be visible in the evening in the western sky, a more or less splendid object according as the effect of the lessening twilight or the increasing distance of the comet be the more important factor in changing its brilliancy.

If the date of perihelion should be April 8, as Messrs. Cowell and Crommelin predict, the circumstances may be quite different. We must then diminish all the dates on the diagram of the comet's path by thirty-two days. The comet will be lost in the twilight in March and reappear from the dawn in April. It will approach much closer to the earth as it passes between the earth and the sun in May, but will be much more nearly in line with the sun, so that at the time of conjunction we shall probably not be able to see it at all for two or three days. For a few days before this, i. e., about May 1, it should be a splendid morning comet and during the latter half of May it should be a fine object in the evening.

One fact which will strike the eye of the reader at once upon examining the table of elements of Halley's comet, which I have given above, is the great change in the period of the comet which may occur from one revolution to the next. It has in some cases amounted to more than two years, and it does not continue in the same direction in successive revolutions but sometimes increases and sometimes decreases the period. The longest revolution so far recorded is that of 1222-1301 and that of 1066-1145 is very near the same, 79 years and one month. The shortest round is the one now being accomplished, being a little less than 74

years six months. This extreme range of over four years in the period renders necessary the most careful and laborious calculation of the effects of the attraction of all the planets upon the comet, and it seems a marvel that the computers have come so near to predicting the exact date of perihelion at previous apparitions. In 1759 Clairaut and Lalande predicted a date twenty-three days too late, but Laplace has since shown that if the mass of Saturn had been accurately known at the time when the computations were made, the error of the final result would have been within nine days. The planets Uranus and Neptune were then unknown so that their influence was entirely neglected. In 1835 five computers obtained different dates ranging from October 31 to November 26. The actual perihelion occurred November 16 so that all were within sixteen days of the true date. Pontécoulant predicted November 14 and so was only two days in error. If the computers for 1910 can beat this record they will do well.

Halley's comet is sometimes spoken of as one of the Neptune family of comets. As a matter of fact Neptune, as the orbit of the comet is now situated, can have very little influence in disturbing it. The inclination of the comet's path is such that it nowhere approaches closer than 750,000,000 miles to Neptune's path. Both the nodes are near the other end of the orbit, near the paths of earth, Venus, and Mars and these little planets have more influence upon the comet's motion than can Neptune have. It is difficult to see therefore how Neptune can have been instrumental in capturing this comet. It is true there is some indication of a shift of the line of nodes around the orbit, and in long ages past the descending node may have been in the vicinity of Neptune; in any case the time is very remote.

### LIVING CELLS WITHOUT NUCLEI.

By DR. VLADISLAV RUZICKA.

It has hitherto been assumed that every living cell consists of a nucleus surrounded by a mass of cytoplasm of different chemical composition (Fig. 1) and it is now universally believed that every living organism consists of a cell or a number of cells. The cell,

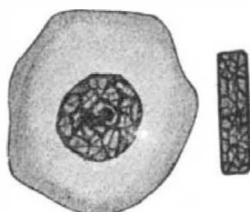


Fig. 1—A Nucleated Cell.

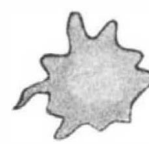


Fig. 2.—Non-Nucleated Parasite Found in Eggs of Certain Worms.

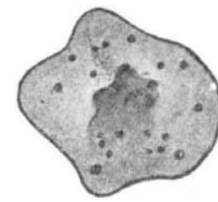


Fig. 3.—The Disintegration of a Nucleus.

therefore, is regarded as a morphological element, or the simplest form in which living matter is capable of independent existence.

But a cell is by no means a simple thing. Even apart from the obvious inference of complexity of physical and chemical structure from the multiplicity of external relations and actions, the complex character of the cell is shown in its division into two parts which differ in chemical composition and in function. This complexity of the cell will remain a stumbling block in the way of the theory of the evolution of life from lifeless matter so long as no living organism simpler than the cell is known. This fact has long been recognized and for a time it was believed that certain cells, called cytodes, consisted entirely of cytoplasm and were destitute of nuclei. Improvements in the technique of the microscope and progress in the study of the lowest organisms, however, have proved this belief to have been erroneous and confirmed the theory of the non-existence of non-nucleated organisms.

But in the establishment of this doctrine two groups of organisms, in which no nuclei could be found by unprejudiced observers, were passed over. These are bacteria and the red blood corpuscles of mammals. The blood corpuscles were assumed to be modified cells and attempts were made to prove that bacteria were nucleated like ordinary cells.

Certain recently published researches in which the newest and most varied methods of investigation were employed give a better insight into the structure of bacteria and red blood corpuscles. These researches were based on the fact that the nucleus of a cell is insoluble and the enveloping cell substance, or cytoplasm, is soluble in artificial gastric juice. Hence the presence or absence of a nucleus, or a nuclear matter, was determined by the behavior of the organism toward artificial gastric juice.

By applying this test to bacteria (1) and the red blood corpuscles of mammals (2) I have succeeded in proving that both of these groups of organisms consist entirely of nuclear matter and McAllum has reached the same conclusion with respect to blue algæ and sulphur bacteria (3). Hence it appears that these organisms, in which no nuclei can be detected by the microscope, are non-nucleated only in the sense that they are nuclei, not surrounded by cytoplasm. But

they are certainly not cells in the accepted meaning of the word. On the other hand, Schewjakoff (4) has described an organism (*Achromatium oxaliferum*) which he regards as consisting entirely of cytoplasm, and Vejdovsky (5) has made a similar assertion in regard to an amœboid parasite which he discovered in the eggs of certain worms (Fig. 2). But in neither of these cases was the chemical test employed to determine the character of the protoplasm under observation, so that we have yet no satisfactory proof of the independent existence of permanently non-nucleated cytoplasm.

Hence, in seeking simpler antecedents of the complete cell we are led to a conclusion diametrically opposite to the view hitherto held. The cytodes, in Haeckel's sense of the word, are not organisms destitute of nuclei, but are organisms destitute of cytoplasm, that is, naked nuclei.

It would be quite unjustifiable, however, to deny *a priori*, the possibility of the independent existence of non-nucleated cytoplasm. We have reason to believe that protozoa, leucocytes or white blood corpuscles and the eggs of low animal organisms can dispense with nuclei, temporarily at least, without suffering injury. In certain stages of the life of these organisms the nucleus is broken up into granules, the *chromidia* of Hertwig (Fig. 3), which are not merely unaltered fragments of the nucleus, but are chemically more nearly akin to cytoplasm, as I have proved (6). At the moment of disintegration of the nucleus, therefore, the organism consists wholly of non-nucleated cytoplasm. Moreover, the behavior of non-nucleated fragments obtained by artificial division of infusoria and similar unicellular organisms indicates that the interaction between nucleus and cytoplasm is not absolutely necessary for the preservation of life, for these non-nucleated fragments can be kept alive for weeks.

The researches quoted above not only prove the existence of organisms which are in some sort less complex than the complete nucleated cell, but they point to new conceptions of the importance of the nucleus and its relations to the cell substance or cytoplasm.

1. Archiv fuer Hygiene, 47, 1903; 51, 1904.
2. Archiv fuer Mikroskopische Anatomie, 67, 1905.
3. University of Toronto Studies, 1900.
4. Nat. hist. med. Verein in Heidelberg, 1893.

5. Boehmische Gesellschaft der Wissenschaften, 1904.
6. Biolog. Zentralblatt, 27, 1907.

—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

### PURIFICATION AND DISINFECTION OF WATER.

THE various methods of filtration, which have been devised for the removal of bacteria from water, having proven ineffectual, search has been made for chemical germicides which are not injurious to health. Ozone nearly satisfies these requirements but the process of applying it requires a supply of electricity and costly apparatus.

Professors Paterno and Cingolani, of the University of Rome, recommend a process which is both cheap and easy of application. It consists merely of the addition of 2 parts of silver fluoride or *tacchiol* to each million parts of water. The silver fluoride reacts with the calcium chloride which is naturally present in the water, forming silver chloride and calcium fluoride, both of which are insoluble. The water becomes slightly turbid, but decantation or coarse filtration renders it perfectly potable. The process costs only a few centimes (5 centimes equal 1 cent) for 1,000 liters (264 gallons) of water and is very effective. Comparative tests have been made of water containing sewage or cultures of bacteria, silver fluoride having been added to some specimens but not to the others. The latter were found to contain from 4,000 to 5,000 colonies of cholera vibriones, from 4,000 to 6,000 colonies of Eberth's bacillus of typhoid, and from 5,000 to 6,000 colonies of the *Bacterium coli* of dysentery, per cubic centimeter, while the treated specimens, a few days after the addition of the silver fluoride, were entirely free from bacteria.

The only iron foundry in Colombia, South America, is at Bogota. It is known as La Paradera, and is operated on a small scale, native ores being smelted, the iron being subsequently re-melted for casting purposes. There are several commercial iron deposits in the interior of the country, and one ore body located near the coast of the Caribbean Sea is now being drilled by American engineers.