In passing under review the treatises whose titles appear above, we do not propose to give a detailed and critical analysis of the individual works; but, rather, taking these as somewhat representative of modern views on the subject, we intend to make some remarks on the so-called "Cell-theory," and direct especial notice to some of its more recent aspects, as manifested in the writings especially of Beale and Huxley.

In considering the cell-theory, as it is called, we may, perhaps, arrive most safely at a conclusion as to its significance, by considering, in the first place, how the idea which the word expresses has arisen. To go back to John Hunter, we find in his writings how, time after time, he repeats the assertion, that each individual part of the animal body is endowed with a separate life. This idea he expresses in one place in these words, and they are certainly sufficiently distinct, "Every individual particle of the animal matter, then, is possessed of life, and the least imaginable part which we can separate, is as much alive as the whole." And to explain more fully his meaning, he compares his idea with the more prevalent opinion. "The principle of life," he says, "has been compared to the spring of a watch, or the moving power of other machinery, but its mode of existence is entirely different. In a machine, the power is
only the cause of the first action or movement, and thereby becomes the remote cause of the second, third, &c.; but this is not the case with an animal; animal matter has a principle of action in every part, independent of the other, and whenever the action of one part becomes the cause of action in another, it is by stimulating the living principle of that other part, the action of the second part being as much the effect of the living principle of that part, as the action of the first part was of the living principle in it.” Hunter, in his investigations on Inflammation, developed this principle more particularly in reference to the blood. He taught that this fluid has life in itself—is not merely a vehicle for conveying nourishment to the tissues, but is in reality a tissue itself, and this none the less that, for convenience of distribution, it is in the fluid form. He showed that, when blood is effused within the living body, it may, under certain conditions, show signs of vitality, the clot which is formed having been observed by him to develop in some cases into a vascular tissue.

In order to account now for this fact of the independent vitality of every smallest portion of animal matter, Hunter devised a hypothesis, which also might be taken as a kind of prophesy of the now much-talked of protoplasm. He supposed that the principle of life which is thus universally distributed in animal matter is a property inherent in a particular variety of animal matter. This form of animal matter he supposed to be diffused through the blood and all the tissues, but to be particularly abundant in the brain. In the blood, Hunter supposed this peculiar substance to have its residence in the coagulable lymph more than in any other constituent, the coagulation of the lymph being one of the first manifestations of life in the blood. To this coagulable lymph Hunter ascribed functions of very great importance. He conceived that in those cases in which, after blood has been effused, organization of the clot ensues, it is the lymph which is chiefly concerned in bringing about this result. But, further, the blood-vessels, he considered, had, under certain conditions, the power of effusing the coagulable lymph without the other constituents, and that the lymph thus thrown out had the power of becoming organized, developing into a tissue corresponding to that on which it was thrown out. In this view he made coagulable lymph play a most important part in the formation of new growths such as occur after inflammation, or such as tumours. He conceived that in all these cases, even in cancerous growths, the first step was the
effusion of lymph, and that the lymph afterwards tended to organize, always, however, with the inclination to assume the form of the tissue into which it was effused.

After the discovery of the cell form, and after it had been shown, especially by Schwann, that the animal cell is quite analogous to the vegetable cell, the views originated by Hunter naturally underwent considerable modification, though we can still for some time trace the influence of his ideas. The plastic lymph of Hunter gave place to the blastema or cytoblastema. This substance had not the power of itself becoming organized, but deposited in its midst the cell form. Schwann considered that this formation of cells within the cytoblastema was analogous to the formation of crystals in their mother-liquor. He supposed that while inorganic matter tends to fall from its solutions in the form of crystals possessing distinct mathematical forms, animal matter tends to fall from its solutions in the cell form. He even went on to describe the supposed process of deposition, first a minute granule appears which forms the nucleolus, and it has the power of attracting matter to it in different layers—first the nucleus, then the cell contents layer by layer, and finally the cell membrane; the process being analogous to that of crystallisation, where the first small crystal grows by deposit in layers of the dissolved substance. In this way the origin of the animal cell was sought to be accounted for; and now, when the various animal tissues were subjected to a thorough analysis, it was found that this cell form recurred under various modifications in each of them. In most of the tissues, however, the cellular elements are separated from one another by an intercellular substance, and this was looked on as the remains of the cytoblastema from which the cells were deposited.

In the hands, especially of Virchow and Good sir, the position became very materially modified. It had been said that the cytoblastema deposited the cells, that the cells are therefore secondary productions. Virchow now says that the cells are primary, and the intercellular substance is produced from them. Looking at the origin of the tissues in the embryo, it is found that originally we have simply aggregates of cells, and of cells which present very little differences among themselves. It is by the modification of these, which may be called indifferent cells, and by the production between them of intercellular substance of various kinds, that the individual tissues are produced. And the cells which we find in the mature tissues are not therefore deposited from
the intercellular substance, but are really the lineal descendants of the cells of the ovum, the intercellular substance being a secondary product resulting from the action of the cells themselves. And while so much stress is laid on the cells in the formation of the tissues, they are regarded by Virchow as playing a no less important part in the mature tissues. He considers that the cell, from its origin onwards, has an independent vitality, and that throughout its life it retains this independence; and as in the course of the development of the tissues the cells in the greater number of cases form around them an intercellular substance, so throughout life do these same cells continue to superintend, as it were, the nutrition and functions of this intercellular substance. The intercellular substance belonging to each cell he thus distinguishes as its territory, the whole body being thus made up of comparatively independent cells with their cell territories. By Virchow, therefore, the body has been compared to a free state, composed of equally independent individuals.

And here it will be observed how wonderfully this principle attaches itself to the views held by Hunter. He considered that there was a principle of life in each individual particle of animal matter, and "the least imaginable part which we can separate is as much alive as the whole." Virchow might say that it is in the cell that this independent vitality resides. So, too, Hunter says that "animal matter has a principle of action in every part independent of the other, and, whenever the action of one part becomes the cause of action in another, it is by stimulating the living principle of that other part." And it might be answered yes; and when the stimulus is conveyed from one part to another, it is the cells which react to that stimulus, and their action is as much the result of their vitality as the action of the other part was of its. When, for instance, a stimulus is conveyed through the nerves to the muscle, the resulting contraction is not the direct result of that stimulus, but the stimulus simply wakens up the contractility of the muscle cells.

In this way, the two principles of Virchow's position may have become clear. The first of these is expressed in his aphorism *omnis cellula e cellula*, all cells are derived from mother cells; and the second is exhibited in his comparison of the animal body to a free state, composed of mutually independent members. That is to say, no cell within the animal body arises *de novo*, but each one is derived from its
parent cell, and the cells so formed have, like the parent cell, an independent vitality, each one performing the offices of nutrition, function, and reproduction for itself and by itself.

Having thus briefly sketched the position of the cell theory, till it has reached, as we may say, its highest point of development, it remains to consider how more modern views have tended to modify this position, or how various observers have viewed the subject. Perhaps we may best effect this object by considering the meanings attached to two words which have in their day been subjected to quite an unusual amount of misuse; these words are, protoplasm and bioplasm.

In nothing is the independent vitality of the individual cells more manifest than in the power of independent motion which many of them have been found to possess. This peculiar power was first discovered in certain animals very low in the scale of life. In these animal forms there is a substance which has the power of contracting and expanding, and by these means altering its shape in manifold ways. This substance, to which the name of sarcode was originally given, in many lower animals, subserves locomotion. In the rhizopods, for example, processes are shot out by the sarcode, and by means of these processes the animal moves along. Typically is this seen in the amœba, where the whole animal seems simply a mass of sarcode, and the entire body is capable of altering its shape, sending out blunt processes according to its requirements. But it was not long before it was discovered that this peculiar contractile power is not confined to the bodies of these lowest animals. It was found that in certain animals the elements of the impregnated ovum present a contractility quite similar to that described. Then the white blood corpuscles were soon found to possess a similar power; they were observed to alter their shape, and shoot out processes in a manner exceedingly like the amœba. The motion of the vibratile cilia was also accounted for by the presence in the epithelial cell of a substance possessing contractility essentially similar to that of the so-called sarcode of the rhizopods. But the observation was carried still further. The cells of almost every tissue in the body have been found to contain a substance which possesses this peculiar power of contractility. It has been observed, as already mentioned in the white blood corpuscles, in cartilage corpuscles, in the connective tissue corpuscles, in the corpuscles of the cornea, in the walls
of capillary blood-vessels, and in other parts, till it has now become the prevalent opinion that in almost every living cell there is a substance possessing this contractile power.

At first, this contractile substance, or sarcode, was regarded as something belonging to many cells, but was not essentially identified with the cell itself. But first, by Max Schultze, and afterwards by most others, this contractile sarcode came to be recognised as identical with the contents of the cell, as an essential constituent of the cell. And now it became necessary to indicate this new position by an alteration of the nomenclature. The contractile substance is no longer a sarcode simply pertaining to the cell, but must now be looked on as one of its essential constituents, and for this purpose the name protoplasm was borrowed from botany. The animal cell has been throughout the discussion compared to the vegetable cell, and sometime previously Mohl had distinguished as protoplasm in the vegetable cell, the colourless viscid granular material which was supposed to be the formative substance. The analogy was then again renewed, and the contractile sarcode of the animal cell became its protoplasm.

To understand the significance which is now attached to this so-called protoplasm, it may be useful to recur to the condition of matters in the ovum. In the ovum we have the animal structure reduced to its simplest elements, and we have also the original stock from which all the tissues of the body are derived. The impregnated ovum, at the very outset of the changes which it has to undergo, divides into a number of cells, and it is these cells which may be looked on as the forerunners of all the cells in the animal body, as the typical original cells. Now, these cells present, on microscopic examination, the appearance of granular viscid semi-transparent masses, containing each a nucleus. The original cell is, therefore, in the words of Max Schultze, a mass of protoplasm containing a nucleus. But the cell so constituted has in itself the power of carrying on an independent life, nourishes itself, has probably contractile power, and produces a second generation of cells. When we pass now to the examination of the fully developed tissues of the body, we find in almost every case that, though the cells do still possess some of this granular protoplasm, yet that this is in some measure replaced by other forms of animal matter. The granular protoplasm may be, in some cases, completely replaced by other substances, as, for instance, in the red blood corpuscle, where a transparent albuminous substance,
globulin, coloured by haematin, composes the cell; or again, in the case of the flat epithelium of the epidermis, and many mucous membranes, where the protoplasm is replaced by a firm dry substance named keratin. Such cells as these are no longer capable of further development, cannot produce new cells, are for most purposes devoid of vitality. But such cells are the exception. In most cases, even in the fully developed tissues, the cells still retain some of this granular, presumably contractile protoplasm, though, as already mentioned, this is, in most cases, partially replaced. Thus we have fat, pigment, and other materials deposited in the protoplasm. It seems as if the protoplasm of the cell then were a kind of index of its powers. We have first the cells of the ovum with the power of forming the whole future tissues inherent within them, and these are composed of masses of protoplasm with a nucleus. Then, as development proceeds, these cells become differentiated, and, losing more and more of their protoplasm, get into a more and more fixed state, till, finally, we have at the opposite pole the epidermic scale, which has lost all its protoplasm, and merely acts as a mechanical protection.

There is, in the adult body, a class of cells, which exhibit still a marked resemblance to the cells of the ovum, in respect, especially, that they present the appearance of a mass of protoplasm with a nucleus. These cells are typically represented by the white blood corpuscle, which, in accordance with this fact of its structure, seems much more than almost any other structure in the body to be possessed of a certain independence. It is well known now that the white blood corpuscle possesses a power of contracting its substance, by means of which it is able to alter its shape, and, by shooting out processes, which act as temporary organs of locomotion, to move from place to place. It is also now pretty well established, that the white corpuscle can, by means of this contractile power, find its way through the walls of the blood-vessels, and, passing outwards, enter on an independent career. Pus corpuscles, which are in some part at least white corpuscles, which have thus escaped from the vessels or their descendants, have a similar power, and they, too, present a similar structure.

These facts, then, in respect to the protoplasm of the animal cell seem to supply a very strong confirmation of the cell theory. It is definitely proved that cells can carry on a most independent existence—can even leave their usual seat, and, if circumstances are congenial, continue to live in another locality. It
appears that almost every cell has a certain amount of this contractile protoplasm, and partakes, therefore, in some degree, of the independence of those which have it as their essential constituent. The cell, therefore, still remains the morphological unit in the animal tissues, albeit the views as to its structure have undergone some modifications.

By a most wonderful perversion, however, this very protoplasm has been used by one writer in such a way as apparently to subvert the entire cell theory. And, as in this country the term itself is perhaps most familiar through that well-known essay, it may be useful as briefly as possible to inquire how this has come about. The line of argument may be represented somewhat as follows:—This substance, protoplasm, is present in almost all cells—is, as it were, an evidence of their vitality. Then this substance connects all cells together; brings them into a kind of unity. The cells of the connective tissue are not very distinct from the cells of bone; both contain protoplasm, let us say the same protoplasm. But again, the protoplasm of man does not differ from that of the lower animals, and that of the lower animals does not differ among themselves, at least, in appearance. So that protoplasm is one in nature and functions throughout the animal kingdom. But, further, we find a substance of similar structure and functions in plant cells. Here, also, appears the omnipresent protoplasm, and the generalization is carried a step further; and it is asserted that the protoplasm of all plants and animals is the same in structure, composition, and functions. The conclusion is obvious, that we have here a universal basis of life. Wherever life is, there is protoplasm; and, per contra, life is but a function of protoplasm. From this the subversion of the cell theory is an easy step. If we had a large mass of protoplasm, we should there have a living mass of protoplasm. It is in no way necessary that the protoplasm should be in cells; it is not necessary that it should be in isolated pieces at all; the cell is not in the least a necessary form; everything depends on the presence of protoplasm and its power of contractility. By a very remarkable progression, Mr Huxley passes even beyond this position, and the steps in his progression are by no means obvious. The cell-form being subverted, and the all-important protoplasm set up as the universal basis of life, he says that every living being is simply a mass of protoplasm. He seems to make no distinction of skin, flesh, or bones, all is protoplasm, and all is the same protoplasm in every animal.

Those vagaries of Mr Huxley have received from Dr Beale, and especially from Dr Hutchison Stirling, a very sufficient
answer. We shall not attempt here to reproduce their arguments. The following quotation from the preface to Dr Stirling's pamphlet puts the matter in a nut-shell:

"If the question involves at bottom logical issues, it has been really addressed by Mr Huxley to physiological ones; and it is only in the interest of scientific accuracy to point out that the inference to a physiological identity has been attempted to be made good by Mr Huxley, solely through means of an unwarrantable trampling out of—perhaps, for the moment, involuntary blindness to—the most essential physiological differences. For example, if you identify all life in protoplasm, the counter-reminder is only fair, that you must equally differentiate all life in protoplasm; for, of no one living thing, and of the organs of no one living thing, is the protoplasm interchangeable with that of another; and this involves, instead of Mr Huxley's identity in power, in form, and in substance, infinite difference in all these respects." (p. 4.)

The protoplasm of the ox never produces the protoplasm of the sheep, or any other protoplasm. Protoplasm does not occur in indiscriminate masses—animals are not made up of heaps of homogeneous protoplasm—but it does occur in every case as a constituent of the cell; that is to say, as a constituent of a minute entity which possesses a quasi-independent existence. It is therefore by an obvious fallacy that this protoplasm has been used to subvert the cell-theory.

We may now turn to another view of the subject, which has also been recently brought forward by an English author, and consider the ideas of Dr Beale, under the designation which he has recently introduced into his system—that of bioplasm. It may be remarked, at the outset, that these views of Dr Beale seem to agree, in most respects, with those already described as involved in the cell-theory itself. There are certainly some differences, but in essentials there is a fundamental agreement; and it is therefore perhaps to be regretted that Dr Beale considers his own peculiar views of sufficient importance to require a new nomenclature.

The term bioplasm, as now used by Beale, is substituted by him for the expression "germinal," or "living matter," which he formerly employed. According to him, if we examine any portion of animal tissue we find in it matter in three forms—first, living matter; second, matter formed from this; and, thirdly, pabulum which the living matter takes up. When we come to inquire into the characters ascribed to this living matter or bioplasm, we find that it alone is supposed to be "concerned in development, and the production of those materials which ultimately take the form of tissue, secretion, deposit, as the case may be. It alone possesses the power of growth, and of producing matter like itself out
of materials differing from it materially in composition, properties, and powers." Again, Dr Beale says:—"One characteristic of every kind of living matter is spontaneous movement. This, unlike the movement of any kind of non-living matter yet discovered, occurs in all directions, and seems to depend on changes in the matter itself, rather than upon impulses communicated from without." Then, again, speaking of the development of the animal tissues, the following expressions are used:—"In the formation of man and the higher vertebrata, the primary mass of bioplasm or living matter absorbs nutriment, and grows, and then divides and subdivides into numerous masses, which are arranged in a definite manner." Dr Beale also supposes that all the bioplasm which is found in the adult tissues is related to this original bioplasm of the embryo by lineal descent, no new formation taking place except by the subdivision of the masses of bioplasm already existing. In respect now to the second form of animal matter, the so-called "formed matter," Beale considers that this has in every case been previously in the state of living matter or bioplasm. The original masses of bioplasm, in the process of formation of the various tissues, become, at their peripheral portions, converted into formed matter of various kinds, according to the tissue which is in the process of formation. If we examine, for instance, the epidemic surface of the skin, we find at the deeper layers that there are simply masses of bioplasm; but as we proceed towards the surface this bioplasm gives place more and more to formed material, till on the very surface the entire bioplasm has been converted into formed material. To Beale, then, the entire animal body is made up of these constituents:—In the first place, innumerable minute masses of bioplasm, each of which has independent vitality, supports itself, absorbs nourishment, grows, and may reproduce its like, but which also tends to be converted into formed matter. This second constituent is, to all intents and purposes, dead; it has no power of independent motion, cannot increase in size, cannot reproduce. The third constituent is the pabulum or nutritive material, which is made use of by the bioplasm. Beale, therefore, also looks on the body as in some measure a free state, made up of mutually independent units; but these are units of bioplasm, and he refuses to call them cells. These units are, as it were, the architects of the bodily tissues, building up the structures in a manner comparable to that in which the coral reef is built by its myriads of polypes, and he regards the formed material of the animal
body as in many respects as dead as the corallum of these animals.

If, now, we compare these views of Dr Beale with the more prevalent ideas, we shall find that his bioplasm is, to all intents and purposes, the same as the protoplasm of other authors, *plus the nucleus*. Bioplasm, like protoplasm, is capable of spontaneous independent motion; it is, in fact, the evidence of life in the tissue. But though Beale acknowledges that the bioplasm is arranged in masses, thereby giving expression to an idea essentially one with that at the basis of the cell-theory, yet he refuses to give any very special significance to the cell form as commonly understood. We have seen that, according to the usual view, the body is divided into cells and intercellular substance, the cells in most cases containing a certain amount of protoplasm. Beale does not recognize any essential distinction between cell and intercellular substance, but only between bioplasm and formed matter. The cell may be, and is generally, made up partly of bioplasm and partly of formed matter, and we may have a tissue, such as epidermis, completely composed of such cells. But, again, we may have a tissue in which the cells are almost entirely composed of bioplasm, but these cells are separated by an intercellular substance composed of formed matter. Wherein, then, consists the difference of the formed matter in this case from that in the case of the epidermis? They both separate the masses of bioplasm, only that the one is within a cell and the other without it. We have said that Beale's bioplasm is equivalent to protoplasm, plus the nucleus. Dr Beale regards the nucleus in a somewhat different light from other authors. There is at present very considerable doubt as to the exact nature of the nucleus, and as to its function in the cell, though its almost universal presence in the cell is sufficient evidence that it has an important function. To Beale, however, the nucleus is simply a new centre of bioplasm, though for what purpose the new centre is required, or why there should be any centre at all, he does not tell us.

There seem to us to be several very strong objections to those peculiar views of Beale. As we have said, fundamentally, they amount to very much the same thing as the more current ones, and it is, therefore, to the strained peculiarity of them that objection may be taken. In the first place, it seems something very like a pure assumption to say, that all the so-called formed matter has been previously in the condition of bioplasm. The apparent reason in favour of this view is,
that at first in the embryo we have only masses of this bioplasm, and that, as the tissues are formed, the formed matter of various kinds is produced. But, as we have seen, this is susceptible of quite a different explanation. In what sense has the firm tissue of bone ever been in the state of bioplasm. That the cell has had to do with its formation, one can well believe, but it must be a very loose way of using the word, to say that the living, moving bioplasm by some means converts itself into the dense calcareous tela ossea. When the mollusc forms its calcareous shell, we do not imagine that a portion of its living substance is in some transcendental way converted into the calcareous formed matter, and in like manner, when the cell produces the various forms of intercellular substance, we do not need to seek for some peculiar conversion of its actual substance into this formed matter. No doubt the cell superintends the process, is the instrument by means of which the structure is elaborated; but this is something very different from saying that the actual substance of the cell is so converted. Another objection to Dr Beale's ideas, is, that he does not seem to lay sufficient strength on the individuality of the separate masses of bioplasm. Beale's bioplasm is, in fact, too much allied to Huxley's protoplasm, although the former would vehemently oppose such a conclusion. He does, indeed, acknowledge that there are multitudes of minute units which are continually at work, forming and regulating the body, but these units lose in great measure their individuality when they are talked of as masses of bioplasm. It is surely much safer, and much more scientific, to call all such independent units, cells, and this word has now become so generalised, that we can make such a use of it. The fact, further, that cells do appear in every tissue, that they can always be recognized by the microscope, as distinct from the intercellular substance where such exists, seems to indicate that they are of more special significance than Beale would acknowledge.

We conclude that the central doctrine of the cell-theory still remains unmoved. The body is still to be regarded as comparable to a free state, in which are myriads of working units, each of which lives a quasi-independent existence, supports itself, and, as a general rule, commands a certain amount of territory. This unit may still be called the cell, although the original idea of the word, that of a vesicle bounded by a membrane, and containing a nucleus and cell contents, is no longer applicable.

We have not attempted, in this article, to trace the process
by which the original idea of the *form* of the cell has been gradually modified, how the cell membrane has been shown to be non-essential, and now even the nucleus is absent in a few cases. Such an investigation would carry us beyond the limits of this review, and we have, therefore, contented ourselves with giving the fundamental principles involved.

II.—*On the Treatment of Diseases of the Skin; with an Analysis of Eleven Thousand Consecutive Cases.* By Dr M'CALL ANDERSON, Professor of Practice of Medicine in Anderson's University, &c., &c. London: Macmillan & Co. 1872.

This book is a thoroughly practical one. It bears in every part the impress of that intimate acquaintance with the treatment of skin diseases which Dr Anderson possesses, and his aim seems to be to convey information in language as simple and direct as possible.

The volume is divided into two parts—the first devoted to the analysis of eleven thousand cases of skin disease, and the second to the therapeutics of diseases of the skin. Of the eleven thousand consecutive cases analysed in the first part, 10,000 occurred in hospital practice, and 1000 in private; and some interesting facts are noted as to the comparative frequency of the same affections in the different walks of life represented by hospital and private patients. After a tabular arrangement of these cases, the author takes up each disease separately, remarking on its peculiar features, and occasionally giving a hint or two as to treatment. In the second part of the work, that devoted to therapeutics, the various remedies used by the author are given, the principles on which a selection of each particular remedy is based are laid down, and the diseases to which each is appropriate are usually mentioned. The local treatment is first taken up, and to this four chapters are devoted, the concluding four chapters being engaged with the constitutional treatment. The value of the work in a practical point of view is still further enhanced by the addition of a copious index, by means of which the various modes of treatment of any particular disease can be at once turned up.

From these remarks it will appear that the work before us is not intended as a text-book of skin diseases for students, but rather as a *vade mecum* for the practitioner, to whom it cannot fail to be of the very greatest service. We would recommend all who are in the habit of meeting cases of skin