very coarse shingle one turns from the erosion hypothesis, and the slightly pitted nature of the rock surface suggests solution. ALEX. STEVENS.

Geological Department, University of Glasgow, May 6.

The Mountains and their Roots.

MAJOR COWIE'S letter in NATURE of May 8 gives the impression that I had the facts of the observations on the deflection of the plumb-line in India before me, and that I made my assumptions as to relative densities, and the mode of compensation by extension of depressed crust beneath the plains, "suitably adjusted," so as if possible to bring out the desired results. This was not the case. I made the assumptions about relative densities which seemed to be *a priori* probable; and it will be seen from the diagram at p. 184 of my "Physics of the Earth's Crust" that fifteen years before I wrote the paper in the *Phil Mag.* I had suggested that compressed mountains would be partly supported by an extension of the depressed crust beyond them.

Should anyone be inclined to undertake the labour of calculating from my formulæ, introducing fresh constants, or other distances, I would warn him that in the *Phil. Mag.* there is a misprint. In the formula for the plateau, after the first bracket, insert x.

I am much pleased that after so long a time my theories are under discussion, and I hope to come well out of it. I am sending to the *Geological Magazine* a reply to some remarks by Sir T. H. Holland in that journal, and to this I would refer your readers as more fully giving my views on some of the points under discussion. O. FISHER.

Graveley, Huntingdon, May 9.

An Application of Mathematics to Law.

I HAVE read Mr. Potts's letter in NATURE of April 24, but am at a loss to understand the use to which he would put his equations.

If it be his object to find some equation giving the validity of a patent or foretelling in any way the probability of its being upheld in a court of law, he has clearly failed to do anything of the sort.

If his equation $I = M + i$ is to be of any value, the quantity i must have a fixed value greater than zero. In fact, however, for any given patent, i may have an infinite number of values, including zero, since each person will have his own idea of the amount of ingenuity that must be shown in the particular case by the inventor. Thus the inventor will certainly put a high positive value upon i, while his opponent will as certainly say that the value of i is zero. It is clear that the value of i can only be finally settled when the validity of the patent has been settled by the House of Lords, and at this stage of a patent's career it is scarcely necessary to have an equation to test its validity. So far as the rest of his letter goes, he seems to have chosen a rather complex method of setting out a few of the chief principles of patent law.

R. STAFFORD CRIPPS.

Fulmer, Slough.

I DID not imagine that my letter would be taken as an attempt to supersede the present methods of determining validity. I intended it as a contribution to the theory which underlies the enormous volume of our case-law on the subject. Surely, as in other cases of the progress from empiricism to science, the first step must be in the direction of mathematical or symbolic expression of the facts. The value of such a symbolism is twofold: first, as an aid to precision of thought; and second, as a preliminary to generalisation. It is a vital principle of English law that all decisions shall harmonise with precedents as much as possible, and on this account alone anything should be of value which assists in formulating generalisations. We admit the value of theory in the physical sciences, apart from immediate practical results: why should an attempt to develop a theory of law be condemned because it does not at once do away with the functions of the judge?

Mr. Cripps's difficulty as to the value of i will not be so great if the actual cases given in my letter are studied. I may add here, however, that it is immaterial what this value is, provided that it is measurably greater than zero. It is settled law that a scintilla of ingenuity is sufficient to support a patent for something new and useful (*cf.* Thompson *v.* Amer. Braided Wire Co., in the House of Lords, and other cases). I therefore employed this symbol merely to indicate that there had to be some positive difference.

HAROLD E. POTTS.

University Club, Liverpool.

SYNTHETIC BIOLOGY AND THE MECHANISM OF LIFE.

THE presidential address delivered by Prof. Schäfer to the British Association in 1912, and the subsequent independent discussion at a joint sitting of two of the sections, served, as was pointed out by Prof. Armstrong in a paper in *Science Progress* in October last, "as a useful corrective to the wave of vitalism that has passed over society of late years owing to the pervasive eloquence of Bergson and other writers." Probably the majority of those who have studied the phenomena of life from the chemical side will agree with Prof. Schäfer in his dictum that "at the best vitalism explains nothing," and accept his opinion "that we may fairly conclude that all changes in living substance are brought about by ordinary chemical and physical forces." The difficulty, however, lies in obtaining any satisfactory information as to what are the actual chemical or physical changes which occur in the real living cells or tissues. Since this discussion was held Prof. S. Leduc, of the School of Medicine at Nantes, has published a monograph [1] in which he approaches the problem from the novel point of view which now for several years past has guided his experiments and with which readers of his "Mechanism of Life" will be familiar.

It is impossible to do justice to the author's arguments or make clear the proper value of his demonstrations in a short article such as the present, but this will at least serve to direct attention to a few of the very remarkable results that he claims to have achieved, which, if verified, are certainly of the highest significance to the student of the phenomena of life.

The basis of Prof. Leduc's work may be summarised in his own words as follows: "It is in the physico-chemistry of liquids that an explanation of the phenomena of life is to be sought"; and he develops his views largely by studying the nature of diffusion in liquids and the phenomena

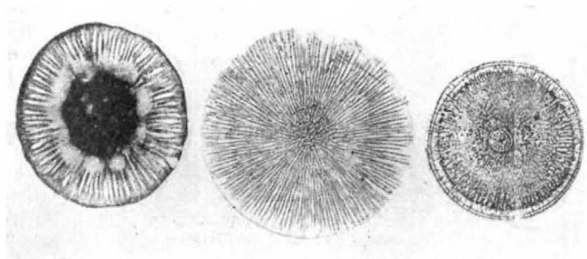
[1] "La Biologie Synthétique." By Prof. Stéphane Leduc. Pp. ii+217 (Paris: A. Poinat, 1912.)

that are thereby produced. He regards diffusion as brought about by currents which radiate to and from the centres of greatest concentration; when a drop of solution of higher concentration is placed in a solution of lower concentration, the drop becomes the centre of symmetrically radiating currents, the one set, consisting of the solution of higher concentration, radiating outwards (centrifugal), the other set (centripetal) radiating inwards and consisting of the solution of lower concentration. "The force producing the currents is the osmotic pressure. Their centres of emission, true dynamic centres or poles, are of two kinds: centres of osmotic pressure greater than that of the medium or positive poles of diffusion, and centres of lower osmotic pressure or negative poles of diffusion. Around these poles of diffusion the dynamic and kinetic phenomena are the same as those which exist in the æther around electric or magnetic poles; the same mechanical laws control them, and a molecule is displaced in the liquid exactly like an ion in an electric field." Photographs are given by Prof. Leduc which show that, for example, a drop of tinted water diffuses into a saline solution along lines which exactly correspond with the discharge from an electric point or with the lines of force from the pole of a magnet. "It is the graphical representation of a centre of force such as was demonstrated by Faraday." Concentric circles of concentration are produced by diffusion which correspond with Faraday's equipotential surfaces.[2]

By utilising differences of concentration and the accompanying osmotic and chemical phenomena under different conditions and with different substances and media, Prof. Leduc states that he has been able to reproduce many phenomena which have hitherto been regarded as characteristic exclusively of living matter. Of a few of these a brief description is appended.

Cell Synthesis.—Of the many different types of cell which Prof. Leduc states that he has "synthesised," the photograph, Fig. 1, shows three varieties: A is an artificial cell produced by a drop of solution of triammonium phosphate in a solution of sodium carbonate and trisodium phosphate; the "nucleus" is large and the analogues of the protoplasmic processes and the enveloping membrane thick. The middle figure B is an artificial aster produced by a drop of water tinged with Indian ink in a solution of potassium nitrate. C shows an artificial cell with interior granulations. When such cells are prepared with a precipitated membrane composed, for example, of calcium carbonate or phosphate, they grow in size owing to the fact that the centripetal diffusion (of water) is greater than the centrifugal, the surrounding membrane becoming correspondingly extended.

Karyokinesis.—The reproduction artificially, by very simple means, of all the phenomena characteristic of karyokinesis is one of the most striking achievements to which Prof. Leduc lays claim. The photograph (Fig. 2) shows four successive periods of cell-division reproduced by diffusion. "If in a saline solution there is introduced between two tinted drops, of less or greater concentration than the solution and representing the centrosomes, a drop of solution very slightly more or less concentrated than the solution and representing a nucleus, all the transformations, all the movements

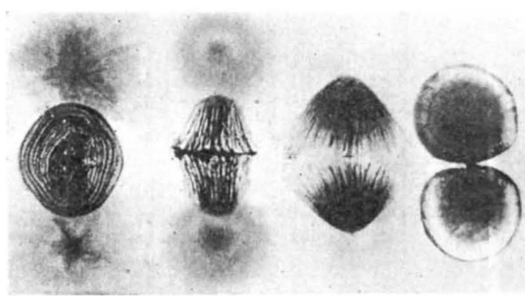


A B C

FIG. 1.

and all the figures characteristic of nuclear division are seen to unfold themselves in their proper sequence and regular order." In the figure A shows the spirem stage, B the orientation of the chromatic substance in the equatorial plane, C the chromosomes on their way to the centrosomes, and D the two final cells produced as a result of the action.

Multiplication.—If an artificial cell is kept for a sufficient time in the liquid from which it has been formed, after a time a furrow appears in the interior of the cell and later other furrows



A B C D

FIG. 2.

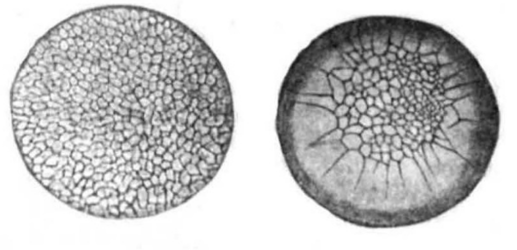
appear which split up the cell into secondary cells, the number of which rapidly increases until the artificial cell becomes nothing but a group of secondary cells—that is, an "artificial morula." Fig. 3 shows a comparison of the germinative disc of a hen's egg (A) with the segmentation of an osmotic cell produced artificially.

Nutrition and Development.—In a chapter on the physiology of nutrition, illustrated by a number of striking photographs which we cannot reproduce here, Prof. Leduc contends that the "facul-

[2] Reference may here be made to a paper by Dr. Horace T. Brown and F. Escombe on static diffusion of gases and liquids, &c. (Phil. Trans., 1900, 193 B, 223), which is not referred to by Prof. Leduc, but substantially corroborates his views on these points. In this paper it is shown that the lines of flow of gas or solute diffusing through a perforated diaphragm are the analogues of the lines or tubes of force, and the shells of equal density or concentration obtained the analogues of electrical surfaces of equipotential.

ties of nutrition, absorption, elaboration or chemical metamorphosis, assimilation, elimination, growth, development, functional differentiation, organisation, inanition and disease are shown by osmotic growths exactly as by living organisms." Striking examples of a comparatively high degree of organisation are given in the chapter on "morphogeny," such, for instance, as the capsular terminations of the filament-like growths obtained with manganese salts, or the "osmotic fungi" which very closely resemble natural fungi in their appearance and structure. One of the most interesting features of these growths is the selective distribution of colour in the different parts, one portion of which may be, for instance, greenish-white, another light green, another part dark green and other parts golden yellow.

Phototropism, galvanotropism, &c.—Prof. Leduc contends that the majority of such phenomena as phototropism, chemotropism and galvanotropism, which have been regarded as essentially vital phenomena, can be artificially reproduced with purely mineral or unorganised material. If, fo example, a bath of a salt solution is placed so that one half is illuminated and the other half



A B
FIG. 3.

is in darkness, and a drop of water tinted with Indian ink is added, "the particles of carbon abandon the illuminated portion and take refuge in the dark part." These and similar results are utilised by Prof. Leduc in a discussion of the nature of the changes occurring in the production of sense impressions. One of the most striking phenomena in this domain, the deformation of the ovule, with the production of a protuberance on the side of the spermatozoid, which Sachs called "the most surprising phenomenon in fecundation," Prof. Leduc claims to have reproduced artificially in a very simple way: If near an artificial cell (hypotonic), produced in a non-saturated solution of potassium nitrate, a small crystal of potassium nitrate be placed, not only is the artificial cell deformed with a protuberance on the side of the crystal, but the lines of circulation within the cell are evidently also influenced.

In this small treatise 118 photographs are reproduced, each of which is said "to be expressive of a fact and to represent the result of a series of experiments." It has here been possible only to outline in the most general manner the character and scope of the work. W. A. D.

SEMI-CENTENNIAL CELEBRATION OF THE NATIONAL ACADEMY OF SCIENCES IN WASHINGTON.

THE National Academy of Sciences of the United States celebrated the fiftieth anniversary of its foundation on April 22–24 at Washington. A special programme was arranged, and many distinguished guests were invited to participate in the celebration. In recognition of the function of the academy as the scientific adviser of the Government, President Wilson, Vice-President Marshall, and Chief Justice White took part in the exercises.

The celebration was held at the Smithsonian Institution, and began on the morning of April 22 with an address by the retiring president of the Academy, Dr. Ira Remsen, who reviewed the history of the organisation and gave an account of the scientific labours of the incorporators, and of the various trust funds of the academy.

Dr. Remsen was followed by President Hadley, of Yale University, whose theme was the relation of science to higher education in America. An address was then delivered by Dr. Arthur Schuster, F.R.S., on international cooperation in research. After a luncheon the academy and guests listened to a brilliant lecture by Dr. G. E. Hale, director of the Mount Wilson Solar Observatory, on the earth and sun as magnets. The lecture was illustrated by lantern-slides and experiments. In the evening a reception was given by the regents and secretary of the Smithsonian Institution, the hosts being Vice-President Marshall and Chief Justice White, Chancellor of the institution.

On the morning of April 23 an address was delivered by Dr. J. C. Kapteyn, director of the astronomical laboratory of the University of Groningen, on the structure of the universe. In the afternoon the academy and guests assembled at the White House, where certain medals and prizes of the academy were presented by President Wilson. Dr. R. S. Woodward, director of the Carnegie Institution of Washington, read the reports of the committee on the awards, after which the President handed the medals and prizes to those who were to receive them, or to their representatives, prefacing his action by brief remarks in which he gracefully referred to the academy as a great society, and as one long associated in an advisory capacity with the Government of the United States. The awards were as follows:—

The Watson medal to Dr. J. C. Kapteyn in recognition of his bold, penetrating researches on the problem of the structure of the stellar universe. Dr. Kapteyn received the medal in person.

The Henry Draper medal to M. Henri Deslandres, of Meudon, France, for his noteworthy researches in astrophysics. M. Deslandres not being present, the medal was delivered to the French Ambassador, M. Jusserand.

The Agassiz medal to Dr. Johan Hjort, of Bergen, Norway, for his meritorious contributions