ume here under discussion, contains an entirely new chapter on ophthalmoscopy by Professor Gullstrand, which was not in the third German edition at all. Professor Gullstrand himself has designed an ophthalmoscope which is a marvel of optical perfection and many other notable ophthalmic instruments besides. Doubtless, many persons are accustomed to think of anatomy as practically a closed subject, so far at least as the human body is concerned; but a reader who will glance at the partial list of more recent bibliography on the anatomy of the eye, compiled by Dr. Davenport Hooker for the English edition, which comprises more than seven pages of fine print in this first volume, will have ample evidence to the contrary.

Apart from Helmholtz's own masterful treatment of the complex problems connected with the dioptrics of the eye (including such subjects as ophthalmometry, corneal astigmatism, chromatic and spherical aberrations, mechanism of accommodation, ophthalmoscopy, etc., in all of which he was the great pioneer), undoubtedly the main value of this volume is to be found in Gullstrand's discussion of these matters from the standpoint of his modern theories of optical imagery. Here he is the acknowledged authority at the present time. The only detailed account of his researches and determinations of the schematic eye which have ever been published in English appears in these pages; together with his articles on refraction, mechanism of accommodation, spherical aberrations, etc. For this reason, if for no other, this particular volume should be of literally incalculable value to scientific ophthalmologists both in this country and in England, and indeed to oculists and optometrists generally.

The Optical Society of America certainly deserves much credit for bringing out this translation of the definitive edition of the "Handbuch der physiologische Optik." The English scientific world should be grateful especially to Mr. Adolph Lomb, because, as the editor states in his preface, without his "continual advice and encouragement" the great undertaking could never have been brought to successful completion.

The second volume, on "The Sensations of Vision," which is now ready also, contains 480 pages. The third volume, on "The Perceptions of Vision," which is still in preparation, will be about double the size of either of the other two.

The book is not on sale at the regular booksellers. Orders should be sent to Professor F. K. Richtmyer, secretary of the Optical Society, Cornell University, Ithaca, N. Y., or to the Columbia University Bookstore, 2960 Broadway, New York City.

S.

SPECIAL ARTICLES

THE ELECTRICAL CHARGES OF LIVING CELLS

In a recent paper[1] evidence was presented to show that the particles in the interior of living cells bear a positive charge, whereas the particles in the surface layer have a negative charge. The evidence depended in part on the observed fact that Ca and Mg ions tended to make the interior protoplasm more fluid, and that an excess of K, Na or NH_4 ions had the opposite effect. Bivalent ions are adsorbed more readily than monovalent ions, hence Ca and Mg ions furnish a greater positive charge to the colloidal materials (granules, oil-droplets or ultramicroscopic particles) in the interior of protoplasm. This would tend to produce coagulation if the normal charge were negative, but it would have the opposite effect if the normal charge were positive. The observed increase in fluidity when protoplasm is exposed to solutions in which the ratio of Ca or Mg ions is increased indicates a positive charge on the materials present in the interior of the cell. If this reasoning is correct, it is to be expected that trivalent cations should have an even more pronounced effect than bivalent cations like Ca and Mg.

It is hard to work with trivalent cations. Earlier experiments with aluminum chloride on sea-urchin eggs failed to yield results, for it was not found possible to separate the effect of the Al ion from the effect of the H ion always present in a solution of aluminum chloride in sea water. Neutralization of this acidity leads to a precipitation, until there is presumably no more Al ion left in solution. However, by adding small amounts of aluminum chloride to solutions of sodium chloride (in the absence of Ca), it was found possible to obtain solutions containing aluminum which were so near neutrality that the H ion could have no possible effect on the protoplasm. Under these conditions it was found that the aluminum, and presumably the Al ion, acts like the Ca ion, except that its action is at least a thousand times as strong. This is entirely in accord with expectation. Very dilute solutions of aluminum chloride (*e.g.*, m/25000) cause a pronounced liquefaction of the protoplasm in the interior of the cell. Ce ions act like Al ions, but they do not act in as great dilution.

With somewhat higher concentrations of Al or Ce ions, and even in some instances with Ca ions in the absence of all other cations, the adsorption of the cation at the surface of the cell is so great that the normal negative charge at the surface layer is apparently neutralized. As the surface membrane of the cell approaches an isoelectric condition, it be-

[1] Heilbrunn, 1923, *Amer. Jour. Physiol.*, LXIV, 481.

comes increasingly more brittle and is very easily injured. The sign of the charge at the surface may also be reversed, and such reversal appears to be accompanied by a visible swelling of the surface layer. At the same time the interior protoplasm becomes coagulated.

There is a decided variation in the behavior of sea-urchin eggs from day to day. This was at first very puzzling, for under apparently identical conditions the phenomena associated with reversal of surface charge sometimes occurred and sometimes failed to occur. Undoubtedly the charge at the surface of the cell is greater under certain conditions than under others. When sea-urchin egg cells are taken directly from the ovary, the charge at the surface appears to be greater than when the cells are washed in sea water. The difference is marked and it is believed to be due to a greater concentration of HCO_3 or CO_3 ions at the surface of the unwashed eggs. Washing the eggs lowers the concentration of carbonic acid in the sea water surrounding them. This disturbs the carbonate equilibrium and results in a loss of HCO_3 or CO_3 ions from the cell surface. The result is a decrease in the surface negative charge.

Indeed, it seems certain that one source of the charge at the surface of living cells is the diffusion of carbonic acid. Many years ago Ostwald[2] showed that when a semipermeable membrane hinders the passage of certain ions as compared to others, the membrane becomes the seat of an electric charge. There are reasons for assuming that the HCO_3 and CO_3 ions diffuse more readily through the surface membranes of cells than the H ion. If this is true then the exterior of living cells would of necessity always be negative, and this negative charge would be greater the greater the amount of carbonic acid being given off.

On the basis of this view, since we know that during activity of the cell there is a large increase in carbon dioxide production, it is easy to understand why the surface of active protoplasm should be electrically negative as compared with the surface of relatively inactive protoplasm. We are therefore led to a very simple explanation of the action current.

It is hoped to further develop these views and their applications in a more extended paper now in course of preparation.

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[2] Ostwald, 1890, *Zeitschr. f. physik. Chem.*, VI, 71.

DIFFERENTIAL TILTING OF THE CONTINENTAL SHELF OFF THE ATLANTIC COAST OF NORTH AMERICA

RECENT studies of submarine profiles off the Atlantic coast from Florida to Nantucket reveal interesting facts regarding the depth of the outer margin of the continental shelf from Florida northward. Hydrographic charts of this area show that the continental shelf, or submerged portion of the coastal plain, which off southern Florida is only a few miles wide, broadens off the Carolinas and Virginia to 50 to 80 miles, reaches a breadth of 100 miles off northern New Jersey and 150 miles or more off the coast of Maine. The emerged portion of the coastal plain, on the contrary, is broad at the south and narrows toward the northeast until it disappears in the vicinity of Long Island. These facts clearly suggest a progressively greater submergence of the Atlantic coast toward the northeast, emergence toward the southwest, or both.

Projected profiles showing the average form of the sea floor for belts 10 to 15 miles broad were made at frequent intervals along the coast across the continuous shelf adjacent to the continent, not including the Bahama Banks or the second shelf known to occur at great depths farther to the eastward. In a number of cases the margin of the shelf appears rounded or irregular, and the precise position of the edge of the shelf is somewhat difficult to determine. A basis for comparison of the relative positions of the shelf edge was obtained by projecting seaward the normal surface slope of the continental shelf, as shown on the profiles some distance back from the rounded or ragged margin, until it intersects a similar upward projection of the scarp face. These intersections, although not indicating the precise position of the edge of the shelf, may be assumed to vary in elevation about as the edge of the shelf varies. On studying the position of these intersections in various profiles, it was found that they show a progressive increase in depth from Florida northward, as given in the accompanying table. The depths from Nantucket northeastward were obtained from profiles drawn by M. A. Stolfus.

Approximate Relative Depths below Sealevel of Edge of Continental Shelf from the Banks to Florida

Origin and direction of profiled belt	Depth of intersection of shelf surface and scarp in fathoms
From Grand Manan Channel, s.	68
" Cutler, Me., s.	64
" Great Wass Island, Me., s.	60–62
" Dyers Bay, Me., s.	64
" Mt. Desert Island, s.	68
" Isle-au-Haut, Me., s.	66
" Vinalhaven Island, Me., s.	71
" Tenant Harbor, Me., s.	70
" Portland, Me., s.	68
" Nantucket Island, s.s.e.	54
" Martha's Vineyard, s.	54
" Sagg and Wainscott, L. I., s.s.e.	47
" Shinnecock Bay, L. I., s.s.e.	50