locomotives were used, and 1,000 trains per day, each having a carrying capacity for 1,000 persons, were run over them. The rate of speed was thirty miles per hour, or twenty miles including stoppages. The cost was $5,000,000 per mile, of which about four fifths was due to damages to real estate caused by cutting through blocks of buildings and tunneling under houses. In some places the roads ran under graveyards without disturbing the graves and the vaults above.

According to this statement, the cost of building and equipment of the London underground roads has been one million dollars per mile, and the expenses for right of way and land damages four millions dollars per mile. This enormous cost for land would be wholly saved in New York, because here the railway lines would be longitudinal with and run directly under the main streets, without invading private property. But in London, owing to the formation of the city, the underground roads pass athwart the streets and cut through private property in all directions. The citizens of London have ascertained by practical experience that the underground system is the best, have invested in it upwards of eighty millions of dollars, and are annually increasing the investment and extending the works.

Sir Edmund answered a large number of questions put to him by our Commissioners, and corrected several erroneous impressions prevalent here concerning the underground railways of London. He explained the construction of those railroads, and described at considerable length the difficulties encountered in building and running them. He said that 93 per cent of the passengers on the London underground roads traveled only short distances, and only 7 per cent of them were carried to the end of the various routes. This fact was regarded as very important, because it showed that, in selecting a plan of rapid transit, the convenience and facility of those who wish to ride for short distances only ought to be considered.

STEALING BRAINS.

Professor Weisbach, in the preface to the further edition of his "Treatise on Mechanics," makes the following remarks: "As I consider my reputation as an author of much more importance than any mere pecuniary advantage, it is always a pleasure to me to find my 'Mechanics' made use of in works of a similar character; but when writers avail themselves of it without the slightest acknowledgment, I can only appeal to the judgment of the public." What the distinguished author has so clearly laid down is generally recognized as a leading principle by writers and editors. Most writers, for example, are glad to have the widest publicity given to their productions, provided they receive credit for the same; and there are few reputable editors or publishers who neglect this courtesy in copying from books and other periodicals. Still more rarely do writers who are compelled from the nature of their subjects to draw material from all sources omit to state this fact, and give due credit to all from whom they derive information. Recently, however, a very flagrant instance of neglect of this most ordinary courtesy has come to our notice, in a work entitled "Handbook of Land and Marine Engines, by Stephen Roper, Engineer." No reference is made, in the preface of this book, to any authorities who have been consulted; and throughout the text, all credit for data and remarks is, with very few exceptions, omitted. Some illustrative examples are given below; and in every instance mentioned, for anything that the author says, it might fairly be inferred that the matter is original.

1. On page 81 is a stroke table, which is an exact reproduction of the original calculated by Mr. Auchincloss, to be found in "Link and Valve Motions," page 59.

2. On page 39 is a table of the properties of saturated steam, which originally appeared in the eighth edition of the *Encyclopœdia Britannica*, and was copied, with due credit, in Wilson's "Treatise on Steam Boilers," and possibly in other works.

3. On pages 82, 84, and 88 are three tables from "Link and Valve Motions," which were original with the author of that work.

4. On pages 197, 216, 219, 220, and 285 are statements, illustrations, and examples, which were originally given in the "Cadet Engineer," on pages 156, 133, 136, and 24, respectively,

5. On page 227, we recognize a remark in regard to practical men, which originally appeared in the SCIENTIFIC AMERICAN, page 17, volume XXX. Other quotations from the SCIENTIFIC AMERICAN occur as follows: Page 258, the opening remarks of an article on page 305 of our volume XXXII; page 279, the entire article on "The Measurement of a Screw Propeller," which was published for the first time on page 240 of our volume XXXI; page 473, table and example from an article on "Feed Water Heaters," pnblished on page 288 of our volume XXXI.

These are a few of the instances which we have marked. We could fill several columns with similar illustrations; but those already given, selected at random through the book, tell the whole story. In fact, we have never seen a more decided case of wholesale plagiarism, if we except an incident which occurred in our younger days, when the dullest boy in school mounted the platform and attempted to pass off one of Lord Bacon's most profound dissertations as an essay of his own composition. Happily, such instances of literary robbery are very rare, and we are inclined to think that Mr. Roper has sinned rather through ignorance than design. If so, he can even yet make some amends, tardy though they be, by publishing a supplement to his work, in which due credit is given to all authorities which have been used. By doing this, he will both increase the value of his work, and the respect in which he will be held by his fellow men.

TRAUBE'S ARTIFICIAL CELLS.

In the early days of modern chemistry it used to be taught that the compounds produced under the influence of life were different in kind from those of the chemist's laboratory, and subject to different laws. A characteristic of "vitality," indeed, was thought to be its power to reverse or transcend the laws of "dead" matter, death being the surrender of the organism to the forces of inorganic chemistry. It was commonly and confidently predicted that the chemist, however skillful, would never be able to construct the magic compounds formed by the creative power of life: it was even declared impious to attempt it. But chemists were not to be deterred by such objections. They persevered. They built up from inorganic materials first one, then another, then thousands of the so-called organic compounds, and the old theory of vitality was for ever shelved.

A corresponding mechanical theory of life is still held by most physiologists. The mechanism of organic growth is declared to be something quite unlike anything that occurs in the domain of lifeless matter, something utterly beyond the skill and power of man to imitate. Even the lowest of organized structures, it is said, exhibits a power of choice in the selection of food, and an individual mode of development; which combinations of inert matter can never rival. Life is assumed to be something unique, something superior to the crude forces of dead matter; hence the structural forms built up through its agency must be unique; hence it is impossible for man to produce anything like them. The whole chain hangs upon the first assumption, for which proof is lacking.

Seeing that the physiology of growth hinges on the life history of the cell—all organized bodies consisting simply of a more or less simple aggregation of these organic elements—the success which Traube has had in imitating with dead matter the characteristics of living cells shows that it is altogether too early to dogmatize touching man's present or future inability to rival the physics as he has the chemistry of life.

The behavior of those groups of compounds denominated colloids and crystalloids by Graham, when their solutions are separated by thin membranes from each other or from solutions of crystalline substances, needs no description here. The established fact that dissolved colloids cannot pass through colloidal membranes formed the starting point of Traube's investigations. He was aware of the additional fact that the precipitates of colloidal substances are themselves usually colloidal. It followed, as a natural consequence, that a drop of one colloid, if placed in the solution of another suitable colloid, would be converted into a closed cell by the precipitate formed by the mutual action of the two colloids at their surface of meeting. For example, a drop of concentrated solution of gelatin plunged into a solution of tannic acid is immediately surrounded by a pellicle of gelatin tannate, the thickness of which depends upon the relative densities of the two solutions. This colloidal pellicle is impervious to the colloid solutions, while it allows water to pass through freely. Hereupon most significant phenomena arise. The gelatin within the cell is more concentrated than the solution of tannic acid in which it is immersed; it has in consequence a stronger attraction for water, and absorbs a portion from the weaker solution. To make room for the increased contents of the cell, the pellicle stretches, separating its molecules to such an extent that the outer and inner solutions come in contact, and a fresh precipitate of gelatin tannate is formed between the original molecules. Through the enlarged pellicle, water continues to penetrate, and the process of growth in the cell wall goes on so long as a difference in density exists between the contents of the cell and the surrounding liquid. A firmer pellicle is formed when a little lead acetate or copper sulphate is added to the gelatin. That the growth observed is not a mere stretching of the pellicle occasioned by endosmose is proved by replacing the outside solution by water, whereupon the growth ceases, the formation of new molecules of precipitate being prevented. It will be remembered that the natural growth of living cell walls is by the same process of intussception, or the deposition of new matter between the molecules already existing.

While the cell wall is growing, changes also go on in the interior. So long as a nucleus of undissolved gelatin remains, the artificial cell is spherical. When the enclosed gelatin is all dissolved, the contents become diluted by the inflowing water, the density being least at the top, the heavier solution settling to the bottom of the cell. When sufficiently dilute, the cell contents begin to dissolve the cell-wall at the top; the pellicle of that part becomes thinner and more extensible; as it yields, new matter is precipitated between its molecules; in short the cell grows upward, and often protuberances directed outward are formed, in imitation of living cell growth. Still more remarkable is the behavior of the pellicle of copper ferrocyanide precipitated round a drop of a concentrated solution of copper chloride in a solution of potassium ferrocyanide: or, better yet, according to Sachs, around a small piece of solid copper chloride in the ferrocyanide solution. In the latter case a green drop is immediately formed at the expense of the solution, the precipitated pellicle of which encloses the solid nucleus which is gradually dissolved by the permeating water. Cells so formed manifest active growth and a variety of differences not easy to explain. Some have very thin pellicles, are roundish, and exhibit a slight tendency to grow upward; they usually form a number of small wart-like outgrowths, and attain very considerable dimensions—from 0·4 to 0·8 of an inch in diameter. Others have thick reddish brown pellicles, grow quickly upwards in the form of irregular cylinders, rarely branch, and attain a diameter of from 0·08 to 0·16 of an inch, and often several times that measurement in hight. Sometimes combinations of these two kinds form a sort of horizontal tuberous rhizome-like structure, from which long stalk-like outgrowths arise upward and root-like protuberances downward.

Sachs insists that these pellicles of copper ferrocyanide do not always grow entirely by intussception, as Traube supposed, but sometimes by eruption, as he terms it. In such cases a brown pellicle is formed round the green drop; water penetrates quickly through the pellicle to the enclosed copper chloride, stretches the pellicle rapidly, and at length ruptures it. The green solution immediately escapes through the fissure, but becomes at once coated with precipitate which appears either as an intercalated piece of the previous pellicle, or as an excrescence or branch of it, a process which is repeated as long as any copper chloride remains inside the cell. Besides these solutions already named, Traube experimented also with mixtures of tannic acid with copper and lead acetates, and soluble glass with the same substances, or with copper chloride, etc., and came to the conclusion that every precipitate, the molecular interstices of which are smaller than the molecules of its components, must assume the form of a pellicle when the solutions of its components come in contact.

These pellicle precipitates are peculiarly well adapted for the study of endosmotic processes. They behave very differently from other membranes, being often impermeable to the most diffusible substances, while allowing other compounds to pass through them; and every kind of pellicle has in this respect its own peculiarities. For instance, the gelatin tannate employed by Traube in most of his experiments is impermeable to potassium ferrocyanide but permeable to ammonium chloride and barium nitrate. The pellicle of copper ferrocyanide of the other experiments mentioned is impermeable to barium chloride, calcium chloride, potassium sulphate, and barium nitrate, but permeable to potassium chloride. Again, if a small quantity of ammonium sulphate is added to the solution of gelatin, and a small quantity of barium chloride to the tannic acid, the pellicle formed by their admixture is composed of calcium tannate with barium sulphate deposited upon it, diminishing its permeability: the two solutions can no longer diffuse, but the encrusted pellicle is still permeable to the smaller molecules of ammonium chloride and water. From facts of this sort Traube infers that, in the permeability of pellicle precipitates, we have a means of determining the size of the molecules of different solutions, since only those molecules can pass through a pellicle which are smaller than its molecular interstices, and therefore smaller than the molecules of the solutions which produce the pellicle.

SCIENTIFIC AND PRACTICAL INFORMATION.

OXUVITIC ACID.

MM. A. Oppenheim and S. Pfaff announce the discovery of a new acid named as above, and having the formula $C_6H_2(CH_3, OH, COOH, COOH)$. It results from the action of chloroform on acetic sodic ether.

MANUFACTURE OF ARTIFICIAL ALIZARIN.

The process of manufacture of this substance, as practised in Frankfort, Germany, consists in heating for 3 hours, in earthen vessels, anthracene having its fusing point between 404° and 410° Fah. with one fourth its weight of bichromate of potash and 12 parts nitric acid of a density of 15·04. Anthraquinone is thus formed, and the crude resulting product is dissolved in 6 parts boiling nitric acid, of density 1·5. The dissolving of the anthraquinone is continued until, on cooling, no residue of that substance is precipitated. The solution then contains anthraquinone in a mononitrated state, which is precipitated by water; and on the solution becoming clear, the precipitate is dissolved in from 9 to 12 parts of a solution of caustic soda of specific weight 1·3 to 1·4, heated to about 382° Fah. When the precipitate is no longer augmented by the addition of hydrochloric acid, the heating is arrested. The mass is allowed to cool, dissolved in boiling water, and filtered, and the coloring matter precipitated in the hot solution by means of an acid. The yellow brown deposit is then ready, after washing, to be used for dyeing. The residue on the filter is principally anthraquinone, which is re-used. The manufacture of artificial alizarin is constantly increasing. The German production is estimated at some 1,198,000 lbs. per year.

NEW METHOD OF DETECTING ADULTERATION OF FATTY OILS.

M. Roth employs, as a re-agent for the above, sulphuric acid at 46° B. saturated with nitrous vapors by causing nitric acid to act upon large pieces of iron. At the end of six or eight days, the solution acquires a fine bluish green color, indicative of complete saturation. This re-agent solidifies either partially or entirely the olein of non-siccative oils. The purity of the oil may thus be determined by noting the time which it occupies in solidifying.

DETECTION OF PICRIC ACID IN BEER.

For this purpose, Brunner recommends acidulating the beer with hydrochloric acid, and plunging therein a fragment of woolen thread, and digesting the same in a *bain marie*. After the thread is removed, it is heated with a solution of ammonia. The latter is filtered, evaporated in a *bain marie* to small volume, and a few drops of cyanide of potassium are added. The presence of 0·015 grain of picric acid in a pint of beer is determined by a red color being produced, due to the formation of isopurpurate of potash.