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ON THE APPLICATION OF PHOTOGRAPHY TO PRINTING.

THE publication of Dr. Draper's work on Human Physiology,* presents several circumstances of general interest.

For the first time the attempt has been made, on an extensive scale, to illustrate a book on exact science by the aid of Photography. It is, of course, admitted on all hands, that no matter how excellent drawings may be, they can never approach in reliability to photographic delineations; and this not only as respects objects which, from their scientific uses, derive their value from the precision with which they have been depicted, but equally so as respects those of general art. We look with a very different eye on the representation of some architectural subject, or even landscape, when it has been sketched by the painter, or taken by the photographer. In the latter case we minutely examine every detail, which presents an indescribable charm to us, because we know that mere imagination has had nothing to do with its presence, but that it is there because it is a fac-simile—a truth.

Photography had scarcely been invented when repeated attempts were made to secure these great advantages for typography. Mr. Fox Talbot, who was one of the earliest cultivators of that art, devoted his attention to this subject; and the same has been done more or less extensively by various other persons. In these instances the object was photographically printed, and not retouched by the artist. As an example of this kind of work, we may mention the New York "Photographic and Fine Art Journal," edited by Mr. Snelling, and which from time to time has contained specimens of very great excellence, executed by our most skillful photographers.

This plan, in which the illustration presented to the reader is an absolute photograph, made, so to speak, without human agency, and by the sunlight alone, leaves, of course, nothing to be desired. Unfortunately the present condition of photography is such, that it is only in a few instances we can avail ourselves of these advantages. A book to be illustrated with three hundred of such drawings—a number by no means unusual, and of which it is necessary to publish an edition of five thousand copies—would require 1,500,000 of separate photographs to be made. And no matter what might be the devices resorted to for shortening the labor—such as by printing contemporaneously from several originals—it may be safely asserted that the operation would be wholly impracticable in any reasonable period of time.

Since thus, in the present state of photography, books can not be illustrated by absolute photographs, on any thing of an extensive scale, attempts have been made to obtain aid from some of the older typographic arts—as, for example, by causing the sunlight to yield etchings on copper or steel, and then to print from these plates in the ordinary way. But though some of the ablest artists and photographers have exerted themselves in this direction, no really practical result has thus far been attained.

So therefore, since we can not reach even this degree of excellence, we must descend a step lower. We must prepare the best photographs we may, and transferring them by the hand of the artist to the surface of wood, or stone, or metal, rely upon him to produce therefrom fac-simile engravings. To be sure this is but a very moderate degree of success, since human agency or human skill have a little too much to do with the result; nevertheless the reader will find that the advantages at once accruing are very great—indeed far greater than he probably would have had any anticipation of. It is in this manner that Dr. Draper's book has been illustrated, and we propose to draw from it some proofs of the assertion we have just made.

But before doing this, there is another circumstance that we must explain. Works of exact science derive their value from the accuracy of their minute detail; and this is more particularly the case with those on anatomy, physiology, and the sciences of organization generally. Very often the most important doctrines turn on the ascertaining of the structure of objects invisible to the naked eye. For this

* *Human Physiology, Statical and Dynamical, or a Treatise on the Conditions and Course of the Life of Man; being the Lectures delivered in the Medical Department of the University, by* John W. Draper, M.D., LL.D., *Professor of Chemistry and Physiology in the University of New York.* Published by Harper and Brothers.

purpose, therefore, microscopes must be resorted to, of which those only can be relied on that are of the most modern construction, and of very great cost. A first-class microscope is worth about a thousand dollars, and even at that price is with great difficulty obtained. It requires, moreover, considerable experience and skill in its use; and so many are the optical deceptions, and so great the difficulty in coming to precise conclusions, where the observers can not look simultaneously at the object, and contrast their opinions, but one has to see it after another, that the most remarkable discrepancies are continually arising.

Now if highly-magnified microscopic objects could be taken in all their sharpness on a photographic surface, these difficulties and discrepancies would be at an end. Indeed it may be truly said that the invention of a method accomplishing this would actually lead to a revolution in the sciences in question. Accordingly, attempts have been made, again and again, both in America and Europe, at effecting this object, but not with the wished-for success, until about three years ago, when Dr. Draper completely solved the problem, by a process not hitherto published, but which he has extensively used in the illustration of his book.

We shall now proceed to examine some of these illustrations, with a view of exemplifying, in a miscellaneous manner, the foregoing statements.

People would hardly believe that a mosquito and a man sing in very much the same way. The popular theory is that flying insects make their humming noise by beating the air with their wings. In truth, however, the thing is done very differently. Instead of having only one windpipe, most insects have as many as a dozen, arranged in a row on each side of the body. When they work their wings in flying, the air is made to flow vigorously in and out of these pipes, the outlet of each being furnished with a vibrating valve, just in the manner that an accordeon is fixed. It has been known for a long time that such is the structure, and the adjoining engraving (Figure 1), made from a drawing of the celebrated anatomist, Fabricius, and which we have taken from Roget's Bridgewater Treatise, published in 1839, affords as good a representation of it as was at that time possessed. In the next column we give (Figure 2) an engraved photograph of the same object, as obtained by the microscope. It would scarcely be supposed that we are looking at the same thing, so superior are the delineations of nature over those of art, and so great the improvement of modern microscopes. The latter figure, which is magnified nearly a hundred diameters, very plainly shows that there are a pair of such vibrating valves, or plates, which, letting the air pass between them, give rise to the sound. The music of a mosquito is not, therefore, produced by a single instrument, but by an orchestra of, say, four-and-twenty of the same kind. And any of our lady friends may have a clear notion of what kind of an animal it really is, by imagining a Highland bagpiper working four-and-twenty of his instruments simultaneously, with a sharp iron pipe coming out of his mouth, to suck in his fees.

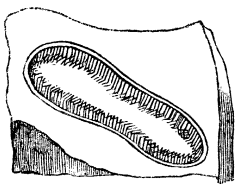

FIGURE 1.

FIGURE 2.

But some one may say, "What is the object of knowing all this? you can not turn it to any practical use." We have, however, just said that the singing apparatus of a man is fixed on the same principle. On the top of his windpipe there are two such vibrating plates—vocal chords, as they are termed—which give rise, by their movements, to the notes of singing. We may again appeal to our lady friends to show how practical advantage comes from these things. Miss Hiawatha Trout (daughter of the retired fishmonger), whose father is a thoroughly practical man, and who was such a belle at all the watering-places last season, has often admired—when she has been to the Opera, at the Academy of Music—the singing of the prima donna there, though perhaps she didn't understand at all what it meant. Now it was just such a pair of vibrating plates, exquisitely organized in the first instance, and got completely under control by long process of education, that enabled the prima donna to obtain a thousand dollars a night. We suppose she considers that to be a practical result!

Or take the case of the Reverend Doctor Barnabas, whose manner of reading the Morning Service is so greatly admired. His more delicate intonations, so clear and fluty—his base voice, so deep, and yet pure. It is because of a pair of these vocal chords that he is worth five thousand dollars a year to his congregation; and if Miss Hiawatha has not forgotten the arithmetic she learned at the French boarding-school, she will be able to calculate that each of them must therefore be worth twenty-five hundred dollars a year. Even her father would admit that this is a practical result.

FIGURE 3.

"I know what Figure 3 represents," observes, in an anticipatory way, Professor Subcuvier. (The Professor holds the chair of Natural History in the University of Norwich.) "It is a telescopic view of the *boa boanerges*, aptly so called, for it winds around its prey as quick as lightning, and strangles it. It is a native of Guiana, and though not a venomous, is yet a vicious beast. Best therefore, in my judgment, seen at a distance, and in parts at a time, as in the figure before us."

But the Professor is altogether mistaken. The figure represents an ultimate muscular fibril, finer than the finest gossamer, and of which there are millions upon millions in his own body. Lean flesh is made up of such things. In this figure the object is magnified nearly a thousand times in diameter. It is actually imperceptible to the naked eye, though so curiously depicted in the microscopic photograph. However, Dr. Subcuvier is right on one point; that is, with respect to the pulling quality of these threads. Almost invisible though they are, they make up by their numbers and unison of action for their individual want of strength, and in this manner all muscular contraction, and therefore all animal motion, is occasioned. They therefore illustrate the doctrine inculcated on his congregation, each Sunday morning, by the Rev. Dr. Barnabas, before alluded to, when taking up a collection, that they should make a long pull, a strong pull, and a pull all together.

Women are more quick in coming to conclusions than men, and, generally speaking, their first impressions are more correct. If we were to ask our friend, Miss Hiawatha Trout, what it is that is represented in Figure 4—with the traces of the volubility she acquired at the French boarding-school, and for which her father, the practical man, paid fifteen hundred dollars per annum—she would doubtless reply,

"Well, it's a specimen of Brussels lace, magnified by the electric telegraph."

Wrong entirely, Miss, it is a piece of your own skin; or, perhaps, more correctly, a piece of a skin like yours. The delicate transparency which those around you so greatly admire, and

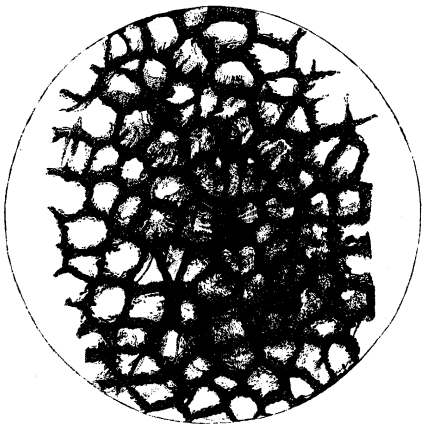

FIGURE 4.

which all those mysterious bottles and powders in your boudoir are for the sake of renovating and preserving, we now perceive to be due to its net-like texture; it is also coarse and shreddy. Upon the whole, we should say it more nearly resembles some of your father's *ci-devant* fishnets than the clear and beautiful surface that you mistake it for.

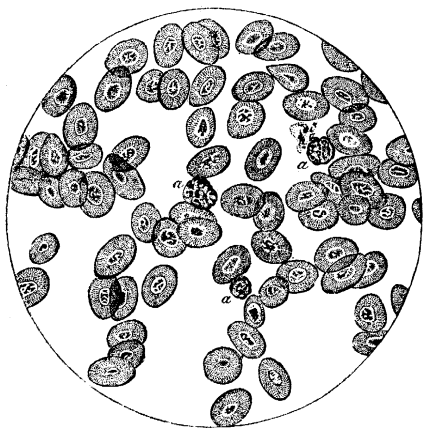

FIGURE 5.

And while we are thus talking of these personal matters, let us direct your attention to what you may see in Figure 5, which represents the little red particles of which your blood is composed. To be sure, there is this difference, that those in your veins are as round as three-cent pieces, whereas these are oval; but in all other particulars they are for the most part alike. We shouldn't like to undertake to tell you how many myriads of these there are in your body. As far as your arithmetic goes, they are countless. Only it's worth while knowing that each of them is as perfect an individual as you yourself are! That each has its time of birth, the time when it reaches perfection, and a moment at which it dies. And these are events not taking place at all slowly, but with wonderful rapidity. For every beat of your pulse, about as many of them die in your veins as there are inhabitants in the United States. It is useless

for you to say that you wish the doctors would keep their nasty secrets to themselves, and not represent one's body as a festering mass of corruption. But perhaps after all, in such a case ignorance is bliss, and that you had been better if left unacquainted with these matters, as are the citizens of New York respecting their Croton water. We once went into the laboratory of a very celebrated chemist, who was employed in purifying some of that liquid for his experiments. He naïvely told us that he was always obliged to put apart the first portions that distilled over, on account of the animal oils and other impurities they contained. And on examining by smelling a portion of the same which he presented us, we became at once penetrated with the justness of his views, and so, indeed, we continue to the present day. But to return to our blood particles, you see their appearance in Figure 6, after they have been put in water;

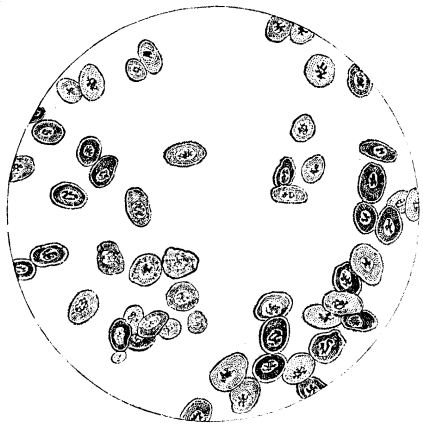

FIGURE 6.

and in Figure 7, how they look after they have been killed by pouring vinegar on them.

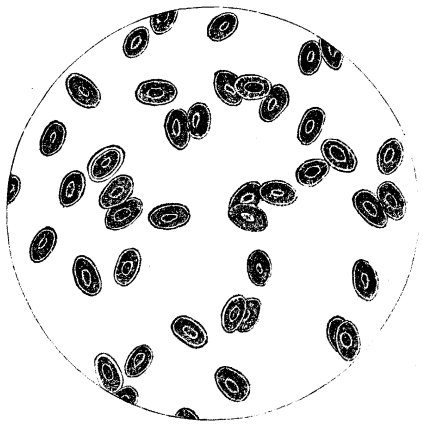

FIGURE 7.

You will farther understand, that just as it is necessary to have an aqueduct to bring the water we have been speaking of into New York, and then iron and leaden pipes to distribute it to all the houses, so it is necessary in the human body, by a like arrangement, to carry the

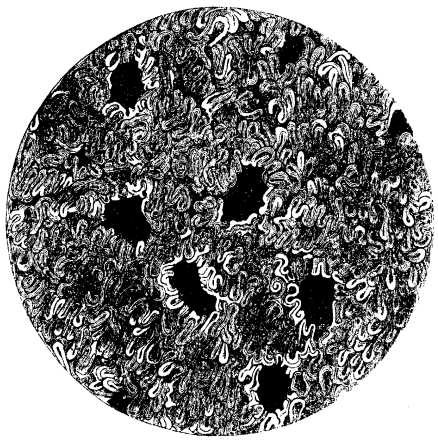

FIGURE 8.

FIGURE 9.

blood to every part. The engraver has very perfectly represented, from microscopic photographs, as you see in Figures 8, 9, 10, the way in which this thing is done, and you perceive what a wonderful net-work it is; myriads upon myriads of little tubes variously intertwined among one another, yet each one having a spe-

FIGURE 10.

cial purpose, as have the hot and cold water pipes that go up to your dressing-room. These representations are taken from the stomach and intestines. All young ladies, Miss Hiawatha,

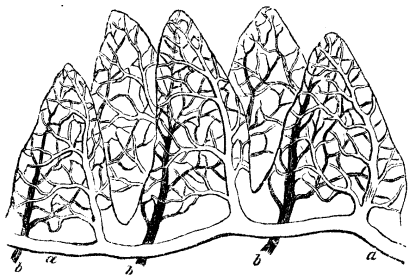

FIGURE 11.

have a stomach and intestine, though they would never infer so from what they've been taught at the French boarding-school. From Figure 11 you will be led to conclude that these vessels are arranged in the same way in men and in monkeys, the figure representing the state of things in the latter case. And as you grow older and become more largely acquainted with the world, you will find many reasons which will satisfy you that the resemblance between these two classes of animals extends much farther than to the particular here pointed out. We may, however, take the opportunity of showing you one point of difference. In man, as you see from Figure 12, the hand can scarcely reach to the depth of the breeches pocket—doubtless you have sometimes observed this to be the case with your father; in the chimpanzee, Figure 13, which most nearly approaches man, it can extend beneath the knee; in the orang-outang, Figure 14, which is the next grade below, it reaches to the heel.

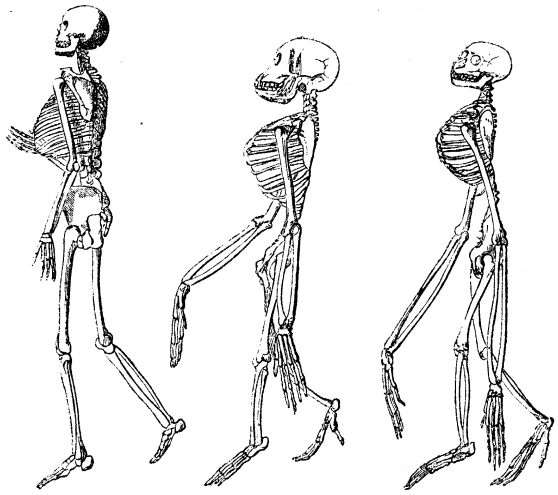

FIGURE 12. FIGURE 13. FIGURE 14.

In Figure 15 is represented a transverse section of a particle of human bone, showing its extreme porosity as seen with a magnifying power of fifty diameters, and, in Figure 16, the turning of cartilage into bone, or its ossification, the black portions representing the bony material gradually intruding themselves in countless ramifications in the cellular structure of the cartilage. It is a microscopic photograph, magnified fifty diameters.

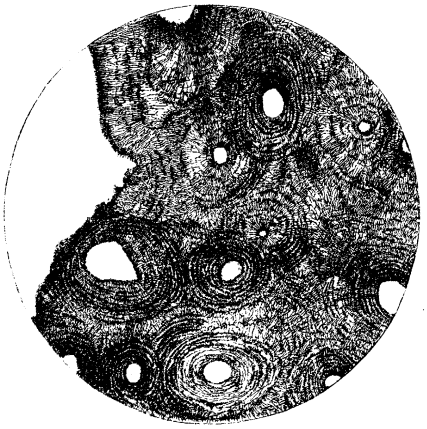

FIGURE 15.

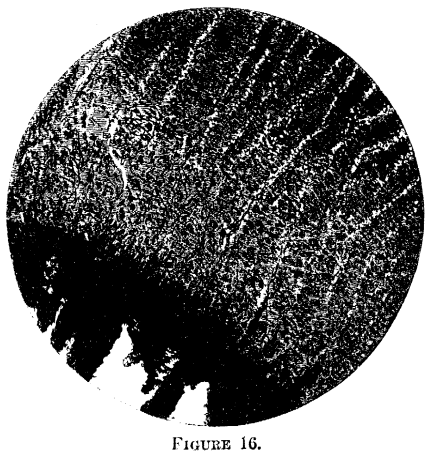

FIGURE 16.

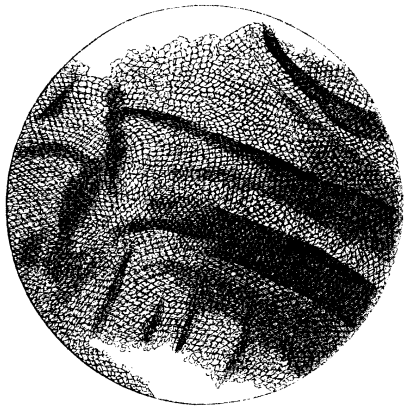

FIGURE 17.

In Figure 17 is a photograph of the lining membrane of the stomach of a beetle. It would answer very well for that of a man. Nature does not make much difference in the two cases.

By way of a change of subject, we present, in Figure 18, one of a delicate shaving of pine

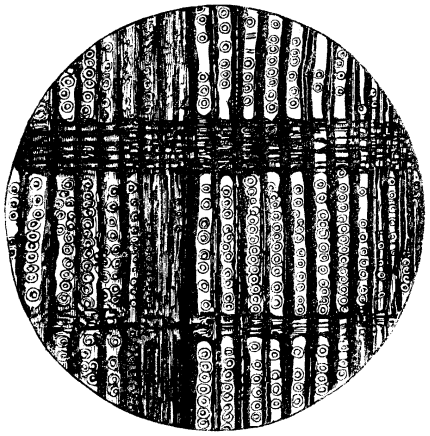

FIGURE 18.

wood, in which may be remarked the rows of round objects, each with a dot in the centre, characteristic of the wood of coniferous trees, and of which geologists sometimes take advantage in determining the nature of fossil specimens. Figure 19 is a photograph of vegetable cellular tissue.

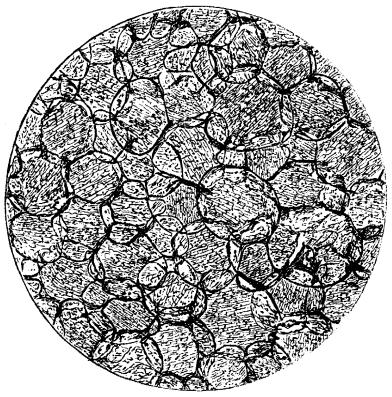

FIGURE 19.

So much for the application of the microscope to photography in the illustration of scientific books. We may next point out the advantages in ordinary photographic copying of large, expensive, or complicated engravings; such, for example, as those which from time to time have been published by European anatomists and artists. Some of these, which are of whole or half life size, from their extreme complexity it would seem almost impossible to succeed in copying on a reduced scale. But this photography accomplishes without any kind of difficulty, enabling us to present to the student, at a cheap rate, these great master-pieces of science and art. The annexed figure of the pneumo-

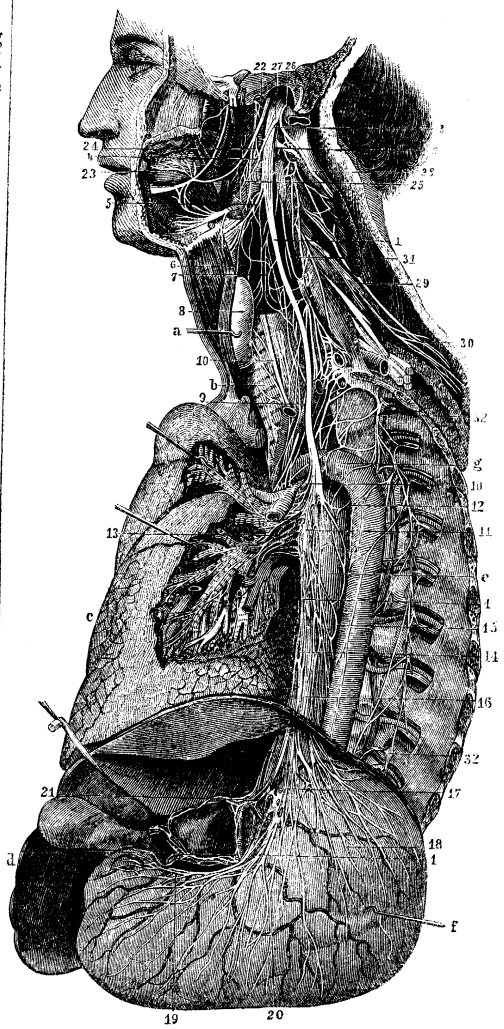

FIGURE 20.

gastric nerve, Figure 20, is an example of the kind. Here, indeed, we encounter a new difficulty, typography not being able to keep pace with photography and engraving. Where large editions, such, for instance, as 168,000 of this Magazine, have to be struck off, it becomes ex-

tremely difficult to retain in each impression the more delicate lines and shades—the little interspaces becoming somewhat filled up with the ink, and the sharpness and beauty lost. There is an engraved photograph of the sympathetic nerve, from a French original, in Dr. Draper's book, which may serve to illustrate these remarks.

Another advantage of this system of copying is, that by resorting to the simple expedients well known to all photographic artists, the copy may be made of the same size as the original, or as much larger or smaller as is desirable, without its accuracy being in the smallest degree impaired.

As examples of this system of copying valued works of art, and thus bringing them within the reach of every one, we may present the engraving of the facial nerve, Figure 21. It is from

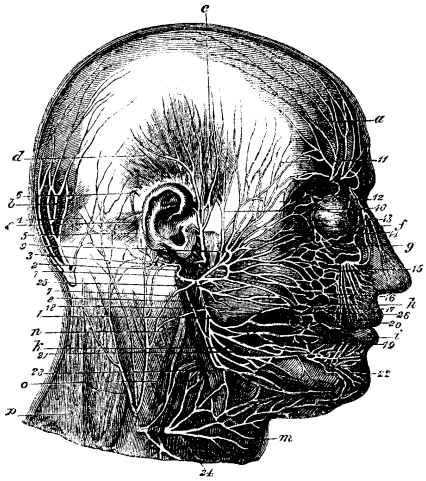

FIGURE 21.

the beautiful work of Ludovic and Leveillè on the anatomy of the nervous system of man, the original being half life size, and the copy one-ninth of that superficial dimension.

As other examples of the same class, Figure 22 represents a section of the eye and eyelids

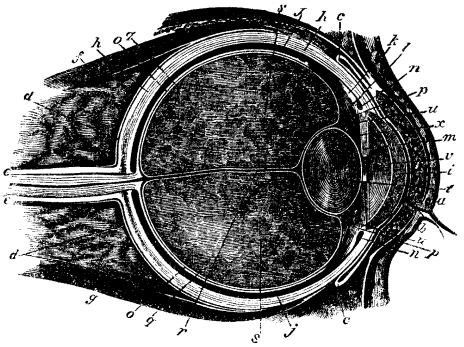

FIGURE 22.

of man; and Figure 23, a profile view of the same, superficially dissected, to show the interior in part.

But the application of photography extends

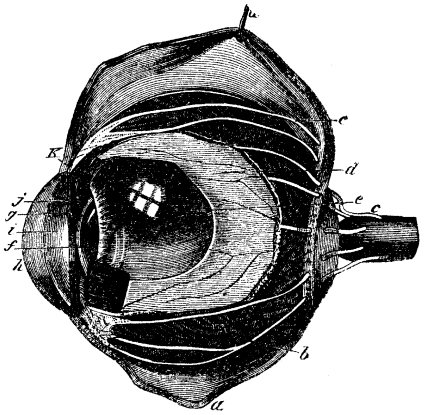

FIGURE 23.

beyond what we have here set forth; it includes also the reproduction, with absolute accuracy, of all kinds of preparations, and in this respect is of essential importance to the advance of anatomy, by enabling the dissector to obtain reliable and durable representations of objects that very soon spoil, and even become disgusting. There is no more difficulty in thus perpetuating a well-made and complicated dissection, than there is in taking the portrait of a living face. We will not trouble our readers with any special human illustrations of this kind; they will not, however, object to look at the digestive tract of a common fowl, Figure 24, which was obtained in this way.

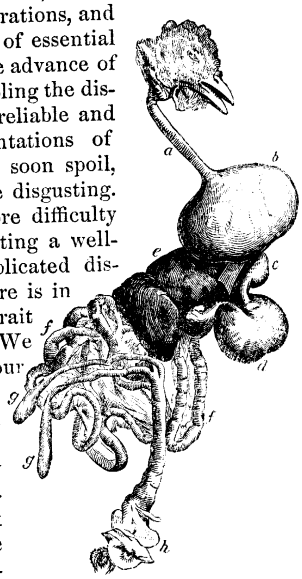

FIGURE 24.

Figure 25 also offers some points of interest.

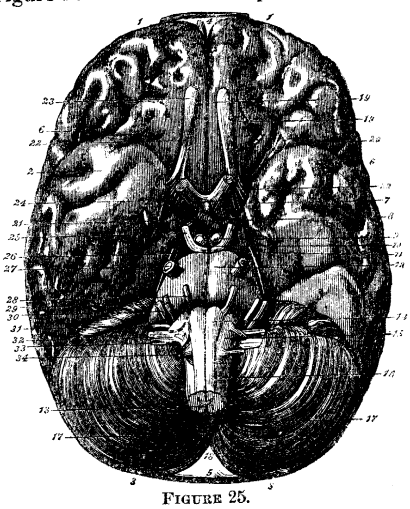

FIGURE 25.

It is the photograph of a wax cast of the human brain, in which the origin of all the nerves arising therefrom is shown, as also the perfect symmetry of the two halves, right and left. Figure 26 shows the upper surface of the brain,

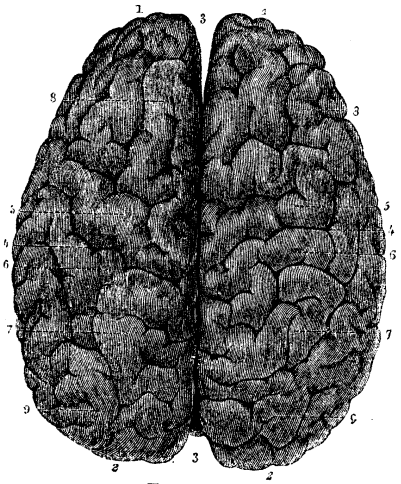

FIGURE 26.

and its symmetrical division into two equal portions, right and left.

We may perhaps profitably conclude this article, by introducing some of the author's remarks respecting this lateral symmetry; a symmetry so complete, that we are actually justified in saying that every individual has two brains, a right and left. This, which might seem at first a mere useless observation, leads us to results of the most profound interest at last.

In insisting on the necessity of a study of the structure of the brain, as the essential basis of the sciences of metaphysics and mental philosophy, our author observes as follows:

"The study of this portion of the mechanism of man, brings us, therefore, in contact with metaphysical science, and some of its fundamental dogmas we have to consider. Nearly all philosophers who have cultivated, in recent times, that branch of knowledge, have viewed with apprehension the rapid advances of physiology, foreseeing that it would attempt the final solution of problems which have exercised the ingenuity of the last twenty centuries. In this they are not mistaken. Certainly it is desirable that some new method should be introduced which may give point and precision to whatever metaphysical truths exist, and enable us to distinguish, separate, and dismiss what are only vain and empty speculations.

"So far from philosophy being a forbidden domain to the physiologist, it may be asserted that the time has now come when no one is entitled to express an opinion in philosophy except he has first studied physiology. I am persuaded that the only possible route to truth in mental philosophy, is through a study of the nervous mechanism. The experience of twenty-five hundred years, and the writings of the great metaphysical intellects, attest, with a melancholy emphasis. the vanity of all other means.

"Whatever may be said by speculative philosophers to the contrary, the advancement of metaphysics is through the study of physiology. What sort of a science would optics have been among men who had purposely put out their own eyes? What would have been the progress of astronomy among those who disdained to look at the heavens? Yet that is the preposterous course that has been followed by the so-called philosophers! They have given us imposing doctrines of the nature and attributes of the mind, in absolute ignorance of its material substratum. Of the great authors who have thus succeeded one another in ephemeral celebrity, how many made themselves acquainted with the structure of the human brain? Doubtless some have been so unfortunate as never to see one! Yet that wonderful organ was the basis of all their speculations. In voluntarily isolating themselves from every solid fact which might serve to be a landmark to them, they may be truly said to have sailed upon a shoreless sea, from which the fog never lifts. The only fact which they teach us with certainty, is that they know nothing with certainty. It is the inherent difficulty of their method, that it must lead to unsubstantial results. What is not founded on a material substratum is necessarily a castle in the air."

In accordance with these principles modern physiologists have commenced the study of mental phenomena, from that of the structure of the brain. As an example of their processes of investigation, we may refer to the new doctrines respecting the doubleness of mental operations, as depending upon the symmetrical doubleness of structure pointed out, in our explanation of Figures 25 and 26.

There can be no doubt that the manner of action of each half of the brain is analogous to the manner of action of each ear and each eye. The two eyes, for instance, do not double the intensity of visual impressions, nor do the two ears make a sound that we are listening to twice as loud as if one alone were employed. Indeed by many simple experiments we can satisfy ourselves that we use only one of these double organs at a time, though we can pass with wonderful rapidity at will from the use of one to that of the other. Thus if a person places his extended hand along his nose, so, as it were, to divide one eye from the other, and then looks at a printed page, he will find that he really reads with one eye at a time, though he can rapidly pass from the use of the one to that of the other at will, and so read the parts of the page that are on either side of the hand, being perfectly conscious, however, of the effort he is obliged to make in passing from one to the other. So with the brain, we never use its two halves at the same moment, but employ one or the other alternately; and many cases are on record where one half of it has been totally de-

stroyed, as by gunshot wound or disease, and the other has officiated passably well, just as we can see with one eye, though the other may have been lost. We have therefore to acknowledge the independent action of each hemisphere or half of the brain, and may conclude that the conjoint use of the two, as in the case of other double organs of sense, is not so much for the purpose of doubling the intensity of effect, as for rendering the impressions more correct or precise, or true. The imperfections of one half are commonly corrected by the other. On this doubleness of structure undoubtedly depends our capability of indulging in double trains of thought, as when we listen in part to a dull sermon, and in part permit the mind to be wandering off on worldly affairs. Where the two halves are acting in precise unison, and in exactly the same manner, the most powerful mental results will arise; but if by reason of differences in their construction, or through temporary disease, there are great differences in their manner of operation, just as when we press on one of the eyeballs with the finger all external objects become distorted and doubled to the sight, so the insubordination of one hemisphere can not be overcome by the other, and insanity is the result. More particularly those strange forms which have long attracted the attention of physicians, and which are known under the designations of double and alternate consciousness, or double life. If we examine critically the case of such an insane man, we may find that he indulges in two distinct trains of thought, each of which, taken by itself, may possibly be sane enough, but it is by his passing from one to the other that incongruities arise. In like manner there can be no doubt that even in the case of the sane this independent and yet double action is observable, as in the operation "of castle-building, as it is designated, in which we permit one hemisphere to act and present fanciful delusions, the other, as it were, watching with satisfaction the operation, and in this respect lending itself to it. Not that for a moment we suppose there is any truth in the ideas suggested; and in this the phenomenon differs essentially from that of dreaming, in which it never occurs to us that the scenes and actions are unsubstantial."

Upon these principles physiologists also explain what has been termed the sentiment of pre-existence. "By this term is understood that strange impression, which all persons have occasionally observed in the course of their lives, that some incident or scene at the moment occurring to them, it may be of quite a trivial nature, has been witnessed by them once before, and is in an instant recognized. This arises from the almost contemporaneous action of the two hemispheres, there being, under the circumstances, a confusion of memory, and we are led to believe that there has been an interval of indefinite duration, when in point of fact it was an impression in each hemisphere, closely coincident in point of time; in the same manner as in dreaming, our mental operations are sometimes carried forward with the most marvelous speed. Thus a sudden sound which awakes us, or even a flash of lightning, which is over in a moment, may be incorporated or expanded into a long dream, diversified with a various multitude of incidents, all appearing to follow one another in an appropriate order, and occupying, as we judge, quite a long time, yet all necessarily arising in an instantaneous manner, for we awake at the moment of the disturbance. Of the same kind is that remarkable deception which is authentically related by those who have recovered from death by drowning, that in the last moment of their agony all the various events of their past life, even those of a trivial kind, have come rushing before them with miraculous clearness." The sentiment of pre-existence may therefore be explained on the principle of the quickly succeeding action of the two halves of the brain.

THE DISMAL SWAMP.

ILLUSTRATED BY PORTE CRAYON.

"Away to the Dismal Swamp he speeds;
His path was rugged and sore,
Through tangled juniper, beds of reeds,
And many a fen where the serpent feeds,
And man never trod before."

MAN, like the inferior animals, has his instincts, less imperious and less reliable, but oftener controlling his godlike reason than most are willing to admit. Possibly we might get along better if these promptings were more frequently regarded. Let philosophers work out the problem; we haven't time at present. But who has not felt the restlessness that precedes the approach of spring, long before the face of nature has manifested any of its indications? that yearning for the open air, while yet the north wind nips ears and noses? that itching to sow and plant, before the frozen earth can receive the seed? that longing for greens, before there are any sprouts? The sap begins to rise in the trees, and the blood courses warmer in the veins, suggesting dreams of blossoms and balmy breezes. What though the snow lies deep and the wind howls—spring is coming!

On the 2d of February, 1856, the sun rose bright, and the crusted snow seemed at last to be yielding to his genial rays. Books had become a bore, and I sallied forth to see my friend Porte Crayon. I found him at a table busily engaged in pointing his pencils, while his knapsack lay upon the floor surrounded by a number of articles which indicated preparation for a journey.

"Good-morning, P——. You see I am getting ready for a trip. I am tired of hearing sleigh-bells and below zero."

"Then you must meditate a journey toward the tropics?"

"Southward, ho! To meet the coming spring, to cull the earliest flowers, and eat green peas in Charleston; to steal upon Old Rip Van Winkle, and sketch him while he sleeps. In short,