**The structure and physiology of the eye, as affording evidences of design, with illustrations : being the substance of a lecture delivered before the Loughboro' Literary and Philosophical Society, March 6th, 1855 / by B.W. Brown [sic].**

(15.)

# THE STRUCTURE AND PHYSIOLOGY OF THE EYE,

AS AFFORDING EVIDENCES OF DESIGN,

## With Illustrations;

BEING THE SUBSTANCE OF A

# LECTURE

DELIVERED BEFORE THE

**Loughboro' Literary and Philosophical Society,**

MARCH 6TH, 1855,

BY


## B. W. BROWN,

MEMBER OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND,
LICENTIATE OF THE SOCIETY OF APOTHECARIES.


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Nihil est in quo manifestius Geometrio artem Deus exercuerit.

Celui qui a forme' L'ŒIL ne verroit--il pas?

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TO

THE PRESIDENT,

VICE-PRESIDENTS,

AND

MEMBERS

OF THE

LOUGHBOROUGH LITERARY AND PHILOSOPHICAL SOCIETY,

THE FOLLOWING PAGES ARE MOST RESPECTFULLY DEDICATED.

# PREFACE.

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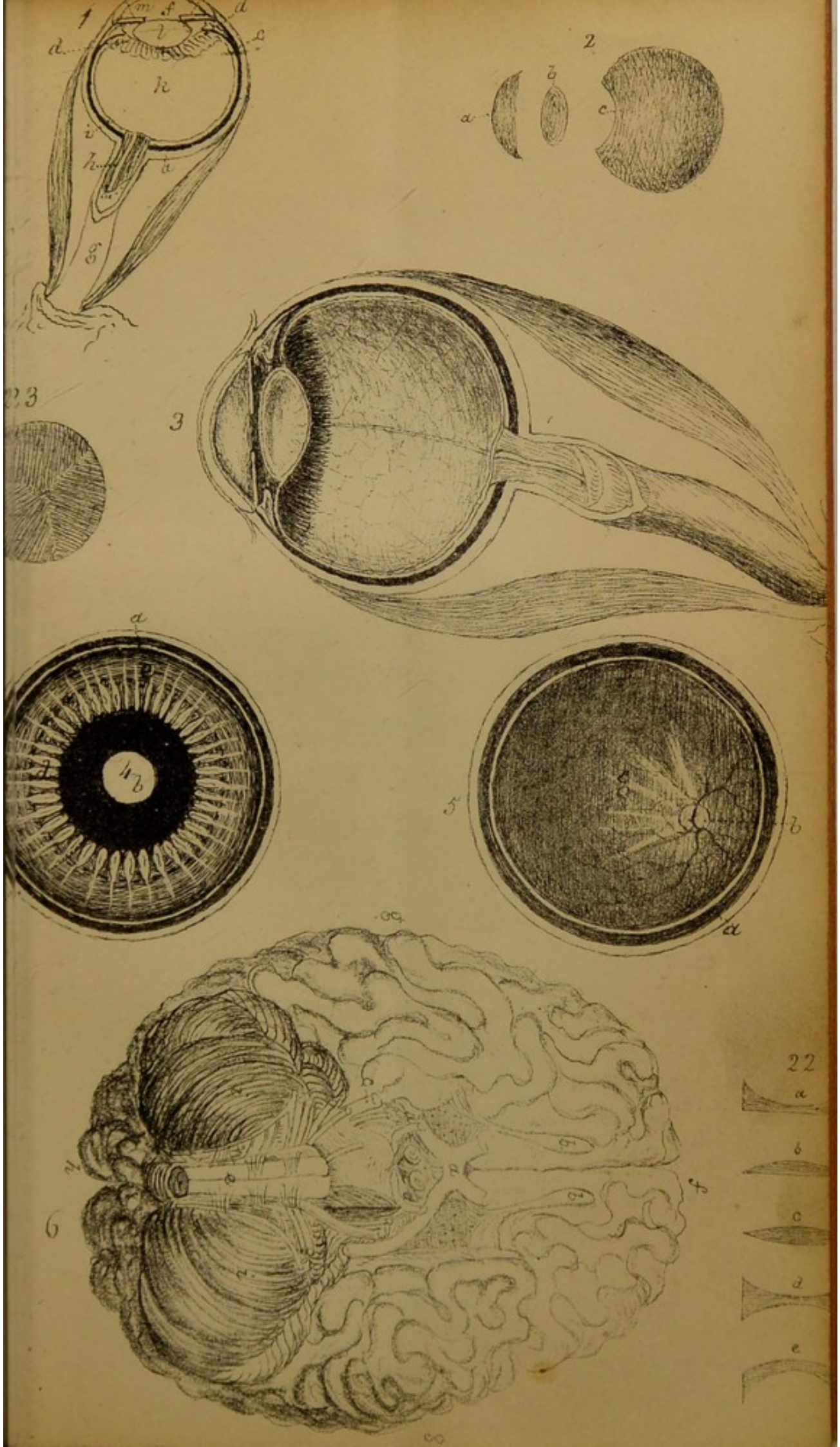
The following Lecture was not prepared with a view to its Publication; but, by the Special request of several Members of the Society, I have consented to place it in the hands of the printer. I do not presume to offer anything of a novel Character to the Scientific; but, if to the *Uninitiated* the publication should prove useful, and be the means of a further consideration of the subject on which it treats, I shall the more appreciate the honour.

The Illustrations have been sketched from the principal of those shewn when the Lecture was delivered.

B. W. B.

Wymeswold,

July, 1855.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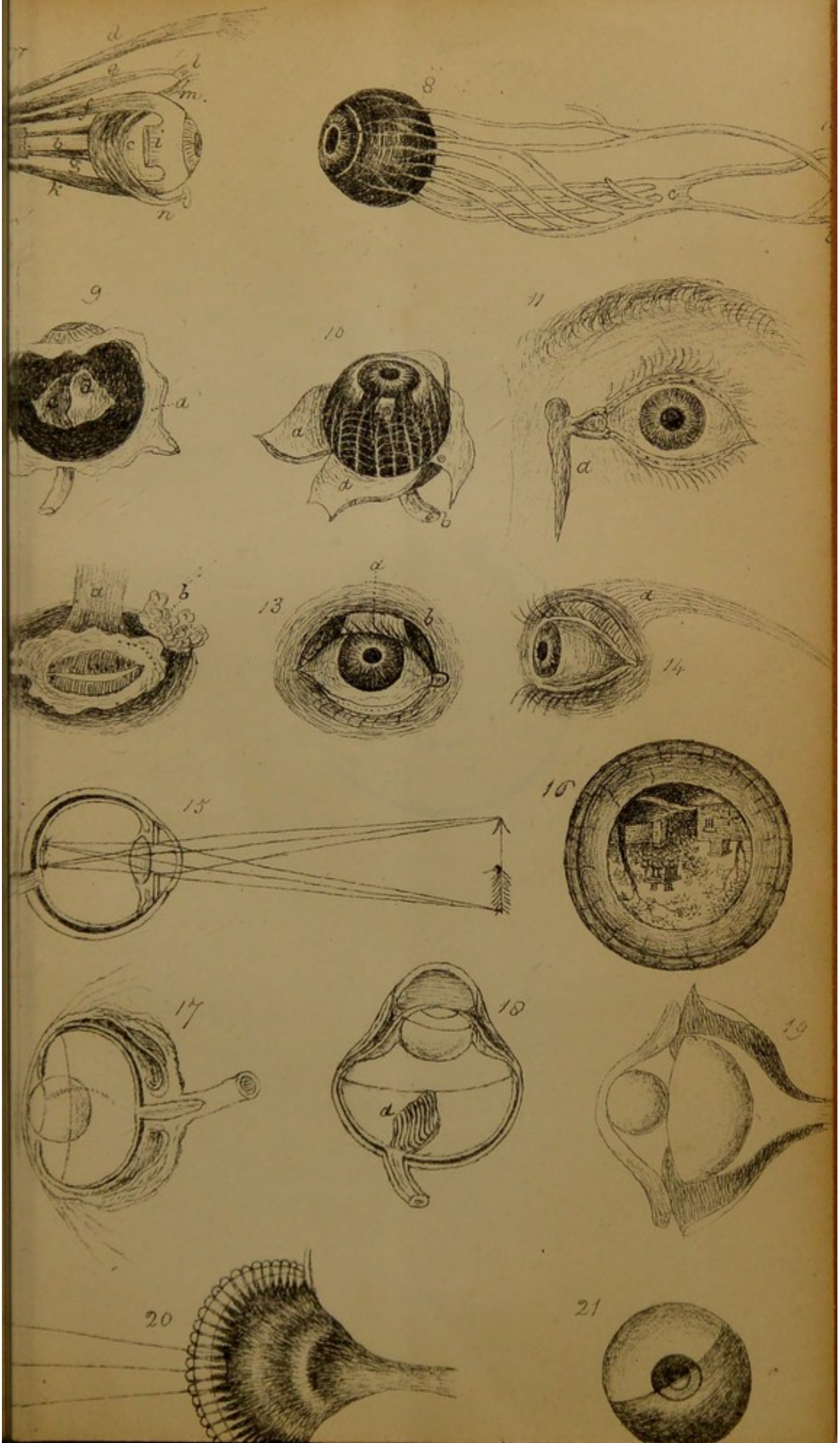
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# EXPLANATION.

Fig 1.—Horizontal Section of the right human Eye-ball,—natural size. *a*—Sclerotic Coat. *b*—Cornea. *c*—Choroid. *d d*—Ciliary Processes. *e e*—Iris. *f*—Pupil. *g*—Optic Nerve. *h*—Part of the same laid open,—shewing the Central Artery. *i*—Retina. *k*—Vitreous Humour. *l*—Crystalline Lens. *m*—Anterior Chamber, containing the Aqueous Humour.

2.—The Three Humours of the Eye.—*a*—Aqueous Humour. *b*—Lens. *c*—Vitreous Humour, shewing its depression for the lodgement of the Lens.

3.—Horizontal Section of the right human Eye-ball, shewing the Cellular Structure, containing the Vitreous Humour. Magnified.

4.—Anterior Segment of a transverse section of the Globe of the Eye, seen from within.—*a*—Divided edge of the three Tunics,—Sclerotic, Choroid, and Retina. *b*—Pupil. *c*—Iris,—the surface presented to view in this section, being the Uvea. *d*—Ciliary Processes. *e*—Scalloped anterior border of the Retina. Magnified.

5.—Posterior Segment of a transverse section of the Globe of the Eye, seen from within.—*a*—Divided edge of the three Tunics,—the membrane covering the whole internal surface, is the Retina. *b*—Entrance of the Optic Nerve, with the Central Artery piercing its centre, and ramifying upon the Retina. *c*—Opening of Soemmering, in the centre of the axis of the Eye,—frequently obscured by folds of the Retina after the Eye has been opened—Magnified.

6.—Under surface or base of the Brain—shewing the origin of the Optic Nerves, and others, which go to the Eye.—*a*—Optic Nerves, shewing their junction. *b*—Olfactory, or first pair, which supply the sense of smelling. *c*—Fifth Nerve of the right side of the Brain, cut off before it proceeds to the Eye. *d d*—Third pair cut off as they

pass to the Eye. *e*—That portion of the Brain which commences with the Spinal Cord,—at its root, several pairs of Nerves are seen to arise, which supply very important functions, not necessary here to describe. *f*—Anterior Lobes of the Brain. *g*—Middle Lobes. *h*—Posterior Lobes. *i*—Cerebellum.

Fig 7.—Muscles of the Eye-balls;—the view is taken from the outer side of the right Orbit. *a*—Small fragment of bone around the entrance of the Optic Nerve into the Orbit. *b*—Optic Nerve. *c*—Globe of the Eye. *d*—Levator Palpebræ Muscle. *e*—Superior Oblique Muscle. *f*—Superior Straight Muscle. *g*—Internal Straight Muscle, almost concealed by the Optic Nerve. *h*—Part of the External Straight Muscle, shewing its two heads of origin. *i*—Extremity of the External Straight Muscle at its insertion. *k*—Inferior Straight Muscle. *l*—Cartilaginous pulley of the Levator Muscle. *m*—Reflected Tendon. *n*—Inferior Oblique Muscle, shewing its origin at the knob of bone broken off.

8.—Nerves which proceed to the Iris, &c. from *a*—the third pair; and from *b*—the fifth pair;—they unite; and form *c*—the great Lenticular or Ophthalmic Ganglion. They pass to the Iris, through several very minute openings.

9.—Sclerotica and a portion of the Choroid Tunics, reflected back, shewing the Retina and Vitreous Humour. *a a*—Sclerotica. *b*—Choroid. *c*—Portion reflected. *d*—Retina and Vitreous Humour.

10.—*a a*—Sclerotica dissected back, to shew the Nerves and beautiful arched appearance of the Vessels of the Choroid Coat. *b*—Optic Nerve. The Ciliary Nerves are seen to pierce the Sclerotic Coat, as they pass forward to be distributed to the Iris. The Ciliary Ligament is here seen,—a portion of which has been removed to shew the passage of the Ciliary Nerves.

Fig 11.—Shews several openings on the borders of the Eye-lids, and the Puncta Lachrymalia,—terminating in *a*—the Lachrymal Duct.

12.—Lachrymal Gland, as seen from within. *a*—Levator Muscle. *b*—Gland, from which a row of small openings are seen, they are the mouths of the several Ducts for the passage of tears.

13.—Shews, *a*—portion of the Levator Muscle. *b*—Muscle which surrounds the Eye—called—the Orbicular.

14.—Another view which shews the Levator passing backward, and part of the Orbicular.

15.—Gives some explanation why the Images are inverted at the bottom of the Eye,—viz., by the rays of light being refracted and crossing each other, where they are perfected in the Lens, and divergence taking place.

16.—Shews how the picture is represented on the Retina.

17—Horizontal section of the Eye of the Whale, or Cod, shewing a large spherical Lens, in contact with a flat Cornea.

18.—Horizontal section of the Eye of the Golden Eagle, shewing *a*—the Pecten,—large quantity of Vitreous Humour,—small Lens, and very convex Cornea.

19.—Horizontal section of the Eye of the Scorpion,

20.—Section of the compound Eye of an Insect, magnified,—shewing how Vision is effected, through a number of beautiful Eyelets or Cones, so constructed and arranged, that Images are erect and not inverted in the Eyes of beings of this class.

21.—Marsupium, or Nictitating Membrane in the Eye of Birds.

22.—Different Lenses used for the purposes of defective vision. *a*—Plano-concave. *b*—Plano-convex. *c*—Double-convex. *d*—Double-concave. *e*—Concavo-convex.

23.—Structure of the Lens, according to Leuwenhoeck,—magnified.

# LECTURE.

Mr. President, Ladies and Gentlemen,

It will be in the recollection of several present, that when I had the honour of delivering the Introductory Address of a former Session, I promised to give a Lecture on the Organ of Vision. Mr. Wood, however, having been pre-engaged to read a paper on the same interesting subject,—I was, at that time at least, freed from my proposition; but, since that gentleman confined himself to the Structure and Functions of the Human Eye, and as the subject of Vision is so vast and comprehensive, it was thought by several of your Committee, that another Lecture on the wonderful Organ would be acceptable and instructive to the Members of the Society,—indeed, other evenings might be well occupied in the prosecution of an examination, and yet, there would be room for further inquiry. Having been solicited to fulfil my engagement, I have, therefore, great pleasure in coming before you this evening, to offer a few cursory remarks on the general Structure of the Eye, connected with its Physiology, as affording evidences of wonderful design; remarks, however, widely different to such as would be suitable for a medical class. It was the wonderful formation of the human skeleton, accidentally discovered, which convinced Galen of his error and

unbelief, and it is recorded proved the very means of his conversion. He had lived a sceptic, and thought everything in nature was the production of chance,—blindly so called,—until finding a skeleton, and viewing the beautiful adaptation of every bone,—the harmony of the whole,—he stood rivetted with astonishment,—the truth flashed upon his mind,—that this could not be the production of chance,—surely, it must be the creation of some Omnipotent Power! He has since left us some beautiful commentaries, written in Latin, on the uses of the several parts of the human body, as hymns and offerings of praise and adoration to the Creator whom he had so long denied. Indeed the mechanism of our body,—the connection and subserviency of all its parts to a common purpose,—the exquisite contrivance of its organs (especially that of Vision)—consisting of such various minute vessels, interwoven with such intricate art, cannot but lead us to acknowledge an infinite and Almighty Maker.

If we consider the Structure and Function of the Eye, in these our prefatory remarks, it will require no lengthened or elaborate argument to display the evidences of a Creative Power;—this alone might shew how blind and senseless is Atheism;—nay, the smallest insect, and the various adaptations which exist throughout the universe, proclaim the creation of one hand alone. No one can contemplate the various adaptations and varieties of one organ, modified by the wants of the beings to which it belongs,—as exemplified for example, in the hand of man,—the paw of the animal,—the fin of the fish,—without confessing the workmanship of a Supreme intelligence. Design is apparent everywhere,—but it is hard to say where it is most apparent;—it may be demonstrated by a hair, as by one of the complex organs of sense;—by the contraction of the smallest vessel, as by the pulsation of the heart itself;—were it otherwise, it would be inconceivable how such consistency and harmony could have taken place in the different parts of our wonderful frame. How could they have so exactly fitted to each other, and to the exterior objects which have an evident relation to them, and the system they

compose? The intelligent mind contemplates the works of the Almighty,—not so much as evidences of His existence, as marks of His wisdom, power, and beneficence,—marks which it perceives in small things, as well as in great. To the intelligent mind, indeed, the faintest star that twinkles in the firmament of heaven, equally with the glorious luminary of our system,—the drop of rain equally with the mighty ocean,—the grain of sand equally with the loftiest mountain,—the infusory animalcule equally with the gigantic whale—bear evidence to the wisdom and beneficence of their Almighty Creator.

Yet, although in everything presented by the fair world around us,—from the smallest to the greatest,—marks of the wisdom and beneficence of God may be perceived,—it is pleasing and instructive, in a high degree, to have our attention directed to instances in which, from the striking harmonious arrangement, wonderful contrivancies, and adaptation of means to ends,—wise forethought and beneficent design are more than usually conspicuous. Perhaps, the history of the senses (especially that of Vision) presents us with such instances of as interesting and instructive a character as are to be met with in the whole domain of nature. In short, whoever, minutely investigates the interesting subject of Vision, finds himself compelled involuntarily to exclaim in terms of the highest admiration of the superior beauty and contrivance of its organ—the Eye. Its exquisite beauty,—the brilliancy of its structure,—the complication of its movements,—its exquisite sensibility,—all tend to excite our astonishment and delight. It is by the Eye we receive that necessary information relative to objects so vast, which the powers of other organs cannot grasp,—the other senses cannot comprehend;—it has been emphatically termed the great inlet—the high road to knowledge, of good and of evil,—it is in fact, the very window of the soul.

Amongst the several senses, it must be almost universally acknowledged, there is none so important, so valuable,—so intrinsically

valuable, as that of Vision. If any of the others are absent, the individual still enjoys the world without, if this one be perfect;—he can enjoy the beauties of creation, and has a thousand other channels of delight;—but, if this be lost,—alas! what a blank does such an one present in God's creation!

Dark—irrecoverably dark to all around!

The predilection for the sense of Vision, may be readily accounted for. It is, because it imparts a continual and unalloying happiness to our minds;—it confirms, and renders everlasting, those ties of affection, by which our hearts are bound to the objects which surround us.

In the hours of reflection and silence, when the heart steals from the anxieties and agitations of the present, to the memory of the past, it is by the agency of this sense that we are enabled to recall the forms of departed friends, and the images of those forsaken scenes, which were associated with the keen enjoyments of our early life;—which were the first tutors of our infant senses, and the field where we first exercised, and first gratified that thirst for knowledge, which is a leading principle of our nature. It is the sense of the affections,—the organ by which the heart receives and reveals its sweetest and tenderest emotions. When the bosom is warm with enjoyment, we see the inward light breaking through the Eye;—and when the heart is pained, it is in the tears, and the depression of this sympathising feature, that we read its agonies.*

Without the aid of this beautiful and wonderful organ, we should be unable to behold and applaud the visible wonders of the Creator;—we should be denied that constant observation of his benefits, which raises our hearts in gratitude and affection towards HIM who fashioned all things into shapes so fair, and tinged them with hues so iridescent and beautiful.

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* Physiologist.

Cast your eyes, in the depth and stillness of a starlit night, upon the heavens ;—those millions of worlds, are by a single glance mirrored forth with accuracy and distinctness on the tablet of your eye.

What an amazing organ is the eye for our contemplation Let us view it as suited to the wants of beings of different elements, as formed in purposed relation to the media through which the light must reach it ;—nothing could be removed from it, that would not damage it ;—nothing could be added, that would not encumber.—Can this be said of any human work ?

We see how that everything in nature is linked together in a chain,—how that all things fit with each other,—shewing at once the unity of design and of the designer. Could the bones and muscles of our bodies, which are so numerous, and so well disposed for motion, be adjusted without a consummate knowledge in mechanics ? Could the Eye, so admirably adapted to light, and appropriated to vision, be formed without a knowledge of optics ? Or the Ear, without the science of sounds ?

Let us examine the organ as a feature of expression ; and here we must take into account its position,—its own muscles,—and the muscles of the face. How quick and varied are its changes ! How glowingly does it depict the inconstant feelings ! now kindled with rapture, or dim with grief !—now distorted with anguish ! or placid with resignation ! We look at the Eye ?—what a lamp and a guide it is to the clinical Physician ! yea, how characteristic of disease !—Mark yonder pitiable object,—having the intellect unclouded, yet, whose muscular frame is agitated with the most frightful throes ;—whose fixed and glassy eye, and piercing pupil, start back with convulsive horror at the approach of liquids,—alas ! a fatal poison has filled his veins, which in a few short hours shall consign him to the tomb.

Behold that fair infant—the pride of its parents,—and it may be an only one;—how glaring and large its pupil—inwardly, upturned! Aye! it tells of a disease which shall quickly remove the little sufferer from the eye of her who has fondly watched over it, and bedewed its dying couch with tears of affection and sorrow!—At length all is over! well may the bereaved parent now sing with the poet—

> Grief fills the room up of my absent child,
> Lies in his bed, walks up and down with me;
> Puts on his pretty looks, repeats his words,
> Remembers me of all his gracious parts,
> Stuffs out his vacant garments with his form;
> Then have I reason to be fond of grief.

I have only alluded to two of the most formidable diseases,* in which the eye is a perfect index, for to the accurate observer I maintain the eye is, on several occasions, as indicative of disease as the pulse.

We look at the eye,—and through it are we not able to read something of that which is passing in the mind, in seasons of love, joy, peace, anger, hatred, revenge, and despair? Where are the affections mirrored so beautifully as here? In joy, how bright and sparkling is the appearance of the eye!—The lid is raised, and the slight gush of tears heightens the brilliancy of its reflection, whilst it seems to start forward, as if eager to meet the impression which has awakened so lively a sensation within the soul.—In sorrow, how touching is its depression!—The lid falls,—the lashes droop, and the eye-ball seeks the earth, as if unwilling to disturb, by the sight of any other object, the memory of that beloved one, which it shall never more behold on earth. How glorious is the fire which fills it, when a tempered zeal for truth, or "injured home and altars" is

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* Hydrophobia, and Hydrocephalus.

swelling in the heart!—Pursue it through all its changes, whether it glistens with compassion,—lights up with courage,—or droops with humility,—and in every instance you will find it the silent tongue of the heart,—the window of the affections.* As the paragon of perfection, well may it be a favourite study of the Poet and the Painter,—who try to represent its numberless expressions;—but neither language nor art can adequately delineate the extacy of its joy, or the mournfulness of its sorrow. In closing these preliminary observations, I am reminded of some exquisite lines by Byron, which are so appropriate to our subject, that I cannot resist the temptation of repeating them;—

Her eye (I'm very fond of handsome eyes)
Was large and dark, suppressing half its fire,
Until she spoke, then through its soft disguise
Flash'd an expression more of pride than ire,
And love than either;—and there would arise
A something in them which was not desire;
But would have been, perhaps, but for the soul [whole.
Which struggled through, and chastened down the

Let us now proceed to investigate the structure of this beautiful organ; and if of necessity I am compelled to adopt Anatomical language in the course of my remarks, I will endeavour to give such an explanation, as to make the subject intelligible to each one present. I may premise, however, what a rich fund of information we English Surgeons discover in consulting the works of Foreign Authors, and doubtless, to many before me, the sound will be somewhat strange, when I tell you the name given to the organ of vision in different languages;—*we* say—the Eye,—the Globe of the Eye;—in Latin—it is Oculus,—Virgil, however, in his classic pages, frequently prefers the word Lumen (light);—in Greek it is ὀφθαλμος (Ophthalmos);—the French say—L'Œil;—the Germans—Auge; and so we might proceed.

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* Physiologist.

The Eye is situated in the Orbit*—a cavity formed of *seven* very thin plates of bones,—all exquisitely hollowed out for the adaptation and protection of the delicate structures they have to surround. The anterior lobes of the Brain rest in part upon the roof of each of these two cavities,—and it is through the openings at the Apices that the Brain communicates with the nerve of Vision—the Optic. The Globe is securely embedded in a large quantity of soft fatty matter,—besides being surrounded by several muscles,—these form a soft and unresisting medium,—thus the Eye has considerable freedom of motion, and is so situated as to give the most perfect range of Vision. The Organ is not quite of a spherical figure;—it is called the Globe—the Apple of the Eye,—and constructed of two different segments,—its anterior segment—comprising one-fifth of the Globe—transparent and projecting;—the posterior segment comprising four-fifths of the Globe. It is composed of Tunics or Coats—partly opaque, and partly not;—these are filled with humours all beautifully transparent, which support its form. There are six of these coverings to the Eye, and it will be better, perhaps, to notice each in turn.

The first which claims our attention is the delicate Conjunctiva—(from the Latin—*con and jungo*)—so called, from its connecting the Eye with the Eyelids;—it is thin, lines the concave, or internal surface of the lids, and is thence reflected over the Cornea where it becomes exceedingly transparent. It is this part—that over the *white* of the Eye, which we at first discover to be the seat of inflammation,—this membrane is the seat of that singular appearance—termed *Bloodshot*. The conjunctiva over the transparent cornea is firmly united, and not readily detached; Animals, however, of the Serpent tribe change their skin, and the conjunctiva falls off with it. Now, we have remarked the membrane is exceedingly transparent over the front of the Eye; yet, that part which lines the lids is very vascular, carrying red blood. Each one may see this for himself.

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* Shewn in the Skull.

The second coat we have to notice is SCLEROTICA (from σκληρος —hard); it is so named from its hardness,—being the most external and by far the most dense covering of the Eye;—this forms the posterior segment of the ball, it terminates nearly in front, and, as you are aware, is of a bluish white colour. It is very opaque, and this is as necessary as the tube of a telescope,—simply because the Eye is a perfect Camera. The covering forms an excellent defence, being firm and elastic, for those delicate and fragile structures which it contains,—viz., the VITREOUS HUMOUR, and the RETINA, which we have yet to speak of.

The Sclerotica, on inspection, is evidently possessed of greater density at the posterior part of the Globe, where little danger might be apprehended, than towards the anterior, where one might believe greater protection was necessary; and in the study of comparative Anatomy, we find this to be the case in all animals. Surely, there must be some evident design for this construction; let us examine a little and pause. Well, this increased density of the covering seems to have reference to the number of Vessels and Nerves which enter the orbital cavity at this point,—particularly the Nerve of Vision, which being large, requires this extra support. We find the tunic very thin towards the front of the Eye, and were it not for the dark coloured secretion within, would be nearly semi-transparent.

In the dissection of the Eye, a considerable roughness may be seen on the surface of the Sclerotica—almost immediately beyond the transparent cornea,—which is designed for the insertion and tendinous expansion of the several muscles which move the Globe. So clearly indicated are the proofs of design by the Great Creator.

If we pursue our examination and inquiry, we observe the coats of the Eye are more dense in fishes, than in those animals which live on the surface of the earth. Do you ask of me the reason? Perhaps, I cannot explain the circumstance better than by giving the forcible language of that distinguished Anatomist and Physiologist, SIR

Charles Bell.—He says, "In viewing the structure of the Eye as adjusted to the condition of fishes, we may remark the peculiar thickness of the Sclerotic coat in the Whale. Although he breathes the atmosphere, and lies out on the surface of the water, to escape his enemies he will plunge some hundred fathoms deep. The pressure, therefore, must be very great upon his surface, and on the surface of the Eye. If a cork be knocked into the mouth of a bottle, so that it resists all further pressure that we can make upon it, and if this bottle be carried, by being attached to the sounding lead, to a great depth in the sea, the pressure of the water will force in the cork, and fill the bottle, for the cork is pressed with a force equal to the weight of the column of water above it, of which it is the base. It is pressed in all directions equally, so that a common sized cork is reduced to the size of a phial bottle." "A copper cylinder containing atmospheric air, was crushed flat, under a pressure of three hundred fathoms." It is a recorded fact, that bottles filled with air or water, when lowered to a great depth,—are usually found burst. Hence, we find a proof of the care which the Creator saw was necessary to bestow on the organization of the inhabitants of the mighty deep, to withstand the pressure constantly made upon them.

We have now to consider the third tunic of the Eye,—this is the beautifully transparent Cornea (from the Latin—Corneus—Horny). It is convex, and is joined to the Sclerotica by a very singular contrivance—which has been termed beveling;—that is,—on its outer edge the Sclerotica overlaps the Cornea, nearly in the same manner that a watch-glass is fixed into its groved case. It is concave within, and as we have already remarked—perfectly transparent; it is so in health,—and has been termed the window of the Eye. It is very remarkable, that if other parts of the body possess vessels carrying red blood,—the blood which passes through the Cornea is divested of all colour. Need we inquire how necessary this should be the case? You are aware if the Cornea becomes inflamed, or opaque from disease or accident, Vision is more or less

obstructed, if not altogether destroyed. Thus we perceive how correct every part is required to be maintained, for the perfection of the whole. Although the Cornea is thinner than some portions of the Sclerotica, it is of so firm and dense a texture, that in cases of cataract, the instruments used in the operation occasionally bend, and it has been said, break, whilst passing through this covering of the Eye. I think, however, if the instruments be well tempered, and properly introduced, no such an untoward accident need happen;—certainly, it has never occurred in my own operations on the Eyes.

If we pursue our examination of the beautiful structure of the Eye, and now remove the Sclerotica—or outer capsule, we notice a very thin, delicate membrane, apparently in close apposition throughout its whole inner, or concave surface;—this is the fourth covering of the Globe,—and is the most vascular of its coats,—in fact,—it appears to consist of a collection of very minute vessels, and on this account, it has received the name of Choroid;* (from—χοριον.) —it joins the Sclerotica, near the edge of the Cornea, and forms a whitish band,—this has been termed the Ciliary Circle,—where it is thrown into a number of regular plaits or folds,—these form the Ciliary Processes,—there are seventy or eighty of them, and are so exquisitely and beautifully arranged, that they have been compared to regular folds of drapery in miniature.

It has been questioned by some Physiologists, whether the choroid can strictly be called a coat of the Eye;—certainly, it is incapable of acting as a defence,—yet it is properly a coat, notwithstanding the fineness and delicacy of its structure. Its inner surface is painted throughout with a black, or dark-coloured substance—Anatomists have given to this the name Pigmentum Nigrum. You are aware when the Optician has constructed a tube for his Telescope, he paints the inside black throughout,—it is precisely so with the

* "Choroide est synonyme de vasculeuse." Cruveilhier.

Eye. The use of this dark colouring I will explain to you when I come to speak of Vision.

In man, this secretion is generally of a dark brown or chocolate colour;—this, however, is not always the case. The colouring matter is much variegated in the Eyes of several animals,—pointing out at once infinite design, in the provision to the wants of the numberless beings in which it is found.—Do you ask then what is the use of the Choroid Coat? Doubtless it is to secrete this dark colouring matter, and the peculiar appearance of this delicate membrane may be seen in most quadrupeds. You will bear in mind it does not in every instance exhibit the dark colour which exists in the human species;—so far from this, the most beautiful, and brilliant tints may be observed painted at the posterior part of the choroid,—you have purple, green, and gold;—and there is a grand design in this magnificent variation, viz.—for the purpose of *reflecting* light, in order to illuminate the images of objects observed in darkness. By this you are enabled to understand why certain animals see better during the night than in the day-time;—the contrivance is most admirable in beings of this class,—those which hunt their prey by night.

The Choroid is of a beautiful silvery white in the Whale;—and I might descant further on the varied tints of this peculiar membrane; but in one short lecture it is impossible to point out these in the Eyes of the vast number of created beings;—but, the more we pursue our examination, the more is the mind impressed with the conviction—that the great Creator has executed everything with matchless skill and perfection.

Before we proceed to examine the fifth covering of the Eye, let us notice the beautiful appearance and arrangement of the Vessels of the Choroid;—from their beautifully arched appearance, they have, with considerable propriety, been compared to the weeping willow.*

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* See the Illustration.

If for Anatomical purposes they are injected with colouring matter, they present a most elegant sight, and evince "a disposition indeed so accurate, so wonderfully distinct, and so constant, that there are few structures of the human body surpassing this in beauty, or more calculated to excite the admiration of the observer." *

There is a remarkable appendage to the Choroid membrane, and only met with in the Eye of birds,—it has received the name of PECTEN,—(from its supposed resemblance to a comb,—Pecten being the Latin for a Comb.) Many have endeavoured to explain the use of this,—never, however, satisfactorily ;—in the Illustration, you will perceive it passes into the Vitreous Humour, and has generally been thought to supply this humour with nourishment, since it appears to be a collection of small blood vessels, and unconnected with any optical arrangements of the Eye.

I have now to describe to you the fifth membrane of the Eye—this is named the IRIS, (Latin for a rainbow)—a structure of exquisite beauty and design. It is called the Iris in consequence of the great variety of colours it presents in different individuals ; most parts of the Eye are hidden, but this magnificent *curtain* is seen by every one ; it has been called the curtain of the Eye—because it is situated between the Cornea and the Lens—thus forming the division of the two chambers of the organ. You will very frequently hear it said, such a person has a blue Eye, or a grey, green, or brown ;—bear in mind then, all these colours entirely depend on the Iris ;—and hence the Eye derives its greatest attractions,—being, in fact, the source of beauty—pre-eminently so, in the human countenance. I have told you this membrane divides the Eye into two chambers,—the ANTERIOR and the POSTERIOR,—but, they are not equal,—the Anterior being the largest. There is an opening nearly in the centre of the Iris for the passage of the rays of light,—this opening, recollect, is

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* Sir John Dalrymple.

the black PUPIL,—it is black, because all is dark beyond the membrane, which possesses the property of enlarging or lessening the size of the Pupil, according as it is influenced by the degree of light. Belladonna applied over the brow will dilate the Pupil so much, that the Iris, in some instances, will appear a mere ring:—the Pupil is situated somewhat nearer the nose, and not in the centre of the membrane;—and here again we cannot fail to be struck with the admirable design,—it is evident it should be so, in order that the AXES of both Eyes might correspond,—or how could they be so accurately directed towards the same object? Were it otherwise, what confusion of Vision would occur! You are well aware we have single Vision with two eyes,—and this might, in part, give some explanation of that extraordinary instrument, the stereoscope,—which so beautifully gives the bas-relief—the *intaglio* of an object.

The Iris is connected at its outer boundary to the Ciliary, or IRIDEAN LIGAMENT, and this being its only attachment, it has the property of moving with singular freedom,—certainly, very requisite under all circumstances for the possession of accurate vision;—a freedom and action which are constantly exercised, independent of our will. The Iris contracts in the dark, and the Pupil is enlarged; but the Pupil becomes a mere black spot during the influence of a very bright light. You may witness this action of the Iris and diminution, or enlargement of the Pupil, in your own persons,—you will perceive how rapidly the Iris will alter the size of the Pupil by the power of light, which is more or less intense. It has been questioned whether the Iris possessed any muscular power,—we need not, however, stop to answer, if we really consider how exquisitely it contracts and expands in light and shade.

The Iris, moreover, is constructed of two different sets of fibres, which appear like so many transverse lines converging towards the centre;—if viewed with a microscope, a rich and elegant appearance is presented. Although the Iris presents such a magnificent display

of colours *anteriorly*,—yet its *posterior* surface we find painted over with a dark coloured secretion resembling the Choroid, to which Anatomists have given the name—Uvea (Latin for a grape);—it has been so called, from its supposed resemblance to the colour of the grape. Do you now inquire "why is the Iris coated at the back with this dark coloured substance?" My answer is—that it may be impervious to light which is so essentially necessary to accurate Vision;—in short, the whole of the interior of the Eye, beyond the Iris, is painted with this dark coloured secretion,—for the very purpose that it may become a perfect Camera—a dark chamber,—no light being allowed to enter, except those rays which are transmitted through the Pupil,—which is, with a very few exceptions, generally round,—in the human species it is so,—this is the case likewise in certain animals, birds, &c.—in the ruminating animals, for instance, the ox, and the sheep, it is transversely oval;—in other classes, as in the cat—it is almost perpendicularly oval;—in the horse, it is obliquely oblong;—in this manner we might pursue our subject, did time allow;—but a few instances have been named, in order to show the variety of shape of the Pupil, and point out the wonderful arrangement which has been suited to the conditions of the different creatures in which they are found.

It is a remarkable fact, that during Gestation, the pupil is entirely closed up by a membrane which does not disappear until a short time before birth, when it becomes absorbed;—when this precise period takes place has not been yet satisfactorily explained;—certain it is, however, at the birth, not a particle remains;—but we behold the Iris contracting and expanding, according to the degree of light and shade.

Do not imagine, in consequence of what has been said, that the interior of the Eye is of a gloomy and dismal character—because only a certain number of rays of light are allowed to enter; for, believe me, when the organ is healthy, and it is occupied in surveying

the iridescent appearances of nature,—a more animated scene can scarcely be conceived;—its walls are then ornamented with the most beautiful and ever changing pictures, possessing the richest and most charming tints, of an exquisite and gorgeous description.

What a variety of colour does the Iris present in the Eyes of different individuals! and how singular it is to notice the relation which appears to exist between the colour of this membrane and that of the hair or skin!—In some animals, you are aware, the hair is white,—this is entirely owing to the absence of this colouring matter which I have been speaking about,—the Choroid and Iris being devoid of colour, a reddish appearance is seen,—no doubt most of you have observed this fiery appearance in the Eye of the white Rabbit;—the same may be noticed in the Albino. Look, however, at the poor African,—the hair, skin, Iris, Choroid, are each very dark, so much so, that the Pupil can with difficulty be distinguished from the Iris. If you notice the Iris in persons of a fair complexion, the hair is light or brown, it is mostly blue, grey, or hazel;—there are, however, a variety of shades.

I now pass on to consider the sixth covering of the eye—which is, the Retina. It is called the Retina (from the Latin—Rete—a net) because it is spread out—being simply an expansion of the Optic, or Nerve of Vision. If you take the fresh Eye of an animal and carefully remove the Sclerotica and Choroid tunics, you will at once perceive the Retina, situated beyond the Iris; it is for the purpose of receiving the images of objects, and communicating those impressions to the brain—whereby we see;—this very delicate membrane you will find between the Choroid Investment and the Vitreous Humour;—it is beautifully transparent in its normal condition, and extends on the back part and sides of the Eye, it embraces the Vitreous humour as far as the outer edge of the Ciliary Processes and Crystalline Lens. You will perceive by the drawing, the Optic Nerve enters the Sclerotic and Choroid investments rather on one

side,—nearer the nose, and not in the centre or axis of the globe,—and this it does by several very delicate filaments,—thus you may learn the reason why the Sclerotic possesses a greater degree of density here than in any other part. The large size of the nerve, and the special care with which it is guarded, seems to indicate its great importance,—for it has been remarked as a general law, that the greater the developement of the nervous system, the more important and more perfect the functions with which it is associated. The Nerve of Vision is admirably protected by a quantity of fatty substance, and by the Muscles which move the Eye-balls;—moreover, it is surrounded with a sheath which proceeds immediately from the Brain;—observe also, how well it is defended by this strong bony cavity,*—whose posterior part it passes through, to unite with its fellow at the base of the Brain.†

Observe how richly the Eye is supplied with other sets of Nerves,—beautifully distributed—which proceed to the Iris,—they are called the Ciliary Nerves;—they do not arise from the Optic, consequently, have nothing whatever to do with Vision,—they simply give life and power to the Muscles which move the Eye, &c. Anatomists have classed the Nerves into pairs;—ten pairs come off from the base of the Brain,—those which supply the Eye are from the *third* and *fifth* pairs, as you may perceive by the drawing.

Having so far considered the several Coverings or Investments of the Eye, we remark it is also composed of Humours or Fluids,—all exquisitely transparent and of different densities;—there are three of these,—the Aqueous, the Crystalline, and the Vitreous. Bear in mind, I told you the Eye is divided into Two Chambers,—the Anterior and the Posterior;—the Anterior is the largest, being the space between the Cornea and the Iris, which divides the Anterior from the Posterior,—the latter being placed between the Iris and the

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* Shewn in the Skull. † See Diagram.

beautiful Crystalline Lens. The two chambers are filled with the Aqueous Humour, and it is essentially necessary for accurate Vision that this fluid be perfectly transparent. In the Operation for Cataract, the fluid generally escapes, and the Cornea falls flat;—it is, however, very quickly afterwards regenerated, and the Eye resumes its former brilliancy, having suffered no injury from its escape. There is no transudation during life; but after death, this does occur,—thus it is that the Eye assumes a glazed appearance, and the Cornea sinks. In man, in birds, and the different animals this fluid is generally most abundant,—in the Eye of the Whale, however, it is absent,—the Cornea is so flat, that it appears in contact with the Spherical Lens, which is exceedingly imbedded in the Vitreous Humour. In the Scorpion, and in the common Perch, the Cornea appears in contact with the Lens.*

I will now endeavour to describe the VITREOUS HUMOUR;—so called from its fancied resemblance to molten glass, a substance which it resembles in nothing except its transparency,—and in this it very far excels it;—thus it derives its name from Vitreum—a Latin word for glass. You will perceive by the Illustration, it occupies the Posterior three-fourths of the Globe;—its form is nearly spherical; but, at its Anterior part, there is a depression for the lodgment of the CRYSTALLINE LENS;—in front are the CILIARY PROCESSES, all beautifully arranged. The Retina surrounds the Humour, which is contained in minute cells; they are, however, invisible in a normal condition of the Organ;—if you expose the Humour to the air, the watery fluid will evaporate, and the cellular structure will remain, or suspend the Humour,—then snip it with a fine pair of scissors, and you will perceive drops of water escape.† If a portion of this substance escapes by accident in the operation of the Extraction of Cataract,—the Eye receives injury, and Vision will be more or less damaged.

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* See the Illustration.

† An experiment of this kind may be tried upon the fresh Eye of a bullock, or other animal.

Now, look at the Crystalline Lens. In an attentive examination of the Eye, you will perceive the three Humours are all exquisitely transparent; but, different in size, shape, and consistence; but, the most important is the beautiful Lens. In the inhabitants of the mighty deep,—there being so very small a quantity of Aqueous Humour, the Lens is large; in Reptiles, however, it is small, there being a larger quantity of the Aqueous and Vitreous fluids;—in the Eye of birds, as well as in that of man, this is remarkably the case; and what is very singular, it varies in shape according to its size:—in the human species, it is rather flat and small,—at the same time the Aqueous and Vitreous Humours are large in quantity;—again, we perceive admirable design in the strict relation which exists between the size and conformation of the several humours of the Eye, according to the circumstances and situation of the creatures to which they belong.

The Crystalline is a solid body, which varies in density;—it is found to be much firmer towards the centre, and more so in old age, than in early life;—it is much flatter at that period, than during infancy;—of course I am now confining my remarks to the Human Eye. The Lens then, consists of concentric layers, and those of Radii,—you are aware, it is placed beyond the Iris, in a depression of the Vitreous Humour, and exactly opposite the Pupil,—it possesses its own capsules or investing membranes of an exquisitely delicate structure. Carefully remove the Lens from the fresh Eye of a bullock, as a simple means of examining this beautiful body, and then try to compare anything to its transparency!—there is nothing to equal it in beauty or transparency. You will be ready to exclaim,—what are all the Lenses which the Optician constructs, when compared with this? The Lens of the Optician is a solid piece of glass, transparent and beautiful to a degree, certainly; but, far excelled by the Crystalline of the Eye. It is impossible he should be able to construct a Lens like that of the Eye—which varies in

different degrees of density,—from the circumference to the centre.*

Having now briefly examined the structure of the Eye, you will perceive how much our pleasures would be diminished if it merely remained a motionless ball in connection with the Brain. But, happily for us, our sources of gratification and delight are enhanced by the additional power which we possess of directing the Eye to whatever point we please,—and without any effort of our own in the accomplishment of the fact,—nay, so rapidly is this effected, that it is almost without our knowledge. How truly miserable we should be without this inestimable enjoyment!

The means then by which these effects are produced, consist of six Muscles, which are placed round the globe at different points. Four of these are inserted on the sides at a short distance behind the Cornea, where it joins the Sclerotica,—they are called the Strait Muscles. The two others—the Transverse or Oblique Muscles, —arise from the edge of the Orbit, and pass to the Globe nearly at right angles,—the one passing above,—the other on its under surface. Observe how beautifully the upper of these muscles passes through a sort of sheath, or pulley, before it is reflected on the Eye-ball. The sheath is perfectly smooth, being constantly lubricated by a sort of oil-bag, situated there for the special purpose, The study of this one Muscle might serve to point out to the reflecting mind, one of the most forcible proofs of design any where to be met with in the animal frame. In the Illustration, observe, just before the Muscle passes through this Pulley,—how it becomes tendinous,—first Muscle,—then tendon,—then again Muscle. Since the External Straight Muscle has a double origin, it evidently has considerable power and latitude of motion. No doubt, it has the power of

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* Take a fresh Lens between your finger and thumb, gently press it, you will perceive it first soft; but firmer as you approach the centre. If you hold a Lens over the type of a page, the letters will appear magnified.

turning the Eye in a different direction, separately;—but, if both portions act at the same time, the Eye will be turned outwards;—whereas, if their actions are separate, it will be drawn upwards or downwards. Having, however, pointed out to you the situations of the powers or levers which move the Eye-ball,—it will be unnecessary to occupy your time by dwelling longer on this part of my Lecture, than to say—the Muscles of the Eye are all with infinite skill so placed and arranged around the Globe, to enable us to turn it in whatever direction we please. Before I proceed, however, to the other part of my subject, there may be some present who may wish to learn the cause of that unpleasant appearance in the Eye—SQUINTING. Why does a person Squint? The cause is simply this,—it arises from the undue action of a set of Muscles over that of their antagonists, and we need not be surprised to find the Eye, in such circumstances, to be most generally turned *inwards*, when we consider the several powers which tend to draw it in that direction.

A few years ago, a distinguished Surgeon visited Nottingham for the purpose of performing an operation for the relief or cure of this unpleasant appearance;—a day was fixed upon for the purpose; a card of invitation to be present was kindly forwarded to me, and a large body of brother practitioners attended. Several persons—chiefly females—submitted to the proposed operation,—many of whom would have been considered *belles femmes*, were it not for the great deformity which their Squinting occasioned. The remedy appeared a simple one,—it was to divide and remove a portion of the Internal Rectus Muscle,* which drew the Eye inward,—thus the deformity was at once removed. So easily can the operation be executed, that by some eminent men it has been thought somewhat remarkable that a single instance of Squinting should remain unrelieved.

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* The part to be divided and removed was shewn in a coloured drawing.

Observe now, in the prosecution of our subject, what wisdom and beneficence are evinced,—what admirable design and contrivance are shewn in the means used for the protection of the Globe from injury. Is our wonder excited? Let us reflect for a moment on the inestimable value of the organ, and how necessary it should have special means of protection. Although the Eye is so situated that it can be directed towards the different objects in the field of Vision, it is securely protected from ordinary external violence. Mark how the organ is guarded by the prominent margin of the Orbit—this seems especially to be the case above, where the EYEBROW arches; thus the effect of a blow is considerably shielded; moreover, how rapidly are the Eyelashes closed, even without an effort of the will, against the intrusion of extraneous particles,—these ornamental appendages seem to present a sort of palisade to the Eye. Occasionally, however, foreign bodies will get into the Eye, as dust, vapours, insects, &c.—thereby occasion great pain; but no sooner is this done, than a gush of tears from the ducts of the Lachrymal gland takes place, and the offending agent is washed away. Against the intrusions of an excess of light, the Eyebrows, Eyelids, and Eyelashes, present a constant barrier. If you look into the Eye of the horse, you will perceive a flocculent substance projecting from the upper portion of the Iris;—this appears to serve as a second Eyebrow,—whereby he is so well enabled to bear the glare and reflection of a road, during the scorching rays of a meridian sun.

In man, the upper Eyelid is kept raised by a Muscle for the purpose,—the LEVATOR;—whilst the lower lid is maintained down by its own elasticity and that of the cheek. Observe the Muscle which is called the ORBICULAR,—its action seems to be that of closing the Eyelids. The power of the Lavator Muscle being suspended in sleep, it is by the unchecked action of the Orbicular Muscle that the Eyelids are kept closed;—it is, moreover, by the momentary action of this Muscle—alternately, that winking is produced.

With regard to the Eyebrows—it is scarcely necessary that I should say more,—it is self-evident they add considerably to the countenance as organs of expression,—in which you will conclude justly, the Eyes greatly participate. The form of these ornamental appendages very much depend upon the arrangement of the Muscles which move them,—and over which the will has considerable influence. By these, man presents an agreeable aspect, or the contrary;—there is the placid Eyebrow, as well as the frowning and contemptuous. When the mind continues tranquil and unruffled, such is the expression of the countenance,—then the Eyebrows and forehead present a pleasing and benign appearance.

Carefully examine the delicate and sensitive borders of the Eyelids,—there you will perceive a number of small openings beautifully arranged,—they pour out a secretion, and serve as another protection to the Eye;—they are the mouths of the ducts which proceed from several small glands—they are called the Meibomian Glands,—so named from their discoverer.

The Eye has another source of protection,—it is in the tears—which are secreted by the Lachrymal Gland;—observe how safely it is lodged above, and to the outer side of the globe, behind the edge of the Orbit. When the tears are poured out in an unusual quantity,—during certain affections of the mind, or from irritation of the Eye from the intrusion of foreign particles, they escape over the margin of the lower Eyelid, and run down the cheek. However, more or less, a flow of tears is constantly going on, in order that the transparent front and surface of the Eye may be washed and maintained in a moist condition.

The tears pass through the channels of the Gland which secretes them, downwards to the inner corner of the Eyeball, and as they accumulate, are drawn off into the nose by the proper ducts.

Now, gently turn down the lower Eyelid in your own persons,

and towards the inner canthus you will readily perceive a slightly prominent papilla, which has a small opening at its point;—a corresponding one is situated in the upper lid. These two bodies are directed towards the depression where the tears accumulate at the inner corner. By the two small openings which lead into a little canal, the tears are absorbed, and by the proper channels are conveyed into the LACHRYMAL SAC, which is seated at the inner corner of the Eye;—the tears thus pass from the Lachrymal Sac, by the nasal duct, into the nose. It is the obstruction of this Sac, or Reservoir, by disease, &c., which constitutes that troublesome affection, termed—FISTULA LACHRYMALIS.

I have now endeavoured to point out to you a short, but general description of the Structure of the Eye,—(time will not allow me to be more minute);—you will thus be the more able to understand something of the Mechanism of the Eye as subservient to Vision. Start not, however, for although I notice a host of Eyes before me, beaming with life and intelligence, yet, believe me, not one of them sees your Lecturer,—the Eye does not see! Let us endeavour to ascertain the fact.

The Retina is the focal point where alone the Images of external objects can be perfected,—thus at this point it is placed to receive those Images. Without the Optic Nerve there could be no Image, and, however perfect the other parts of the Eye might be, if deficient of this, or if its function be destroyed by injury or disease, we should be no better off than if we had no Eye at all. It is certain, if the rays of light which pass through the Pupil, reflected from an object, do not arive at a proper focus, and represent the Image on the Retina, we shall remain in utter ignorance of that object, as to its nature, or qualities. So truly astonishing are the phenomena which constitute Vision, the mind becomes filled with astonishment. How, or in what manner the impressions are, through the Optic Nerve, conveyed to the Brain—the seat of intelligence,—or by what process

a knowledge of them, formed on the Retina, is carried to that organ,—remains, like the mind itself, involved in impenetrable mystery,—the wisest Philosopher cannot explain. Do you wonder to hear it said, that sight does not take place in the Eye, where the Image is represented? Reflect for a moment,—it is in the Brain, where the precious faculty is completed, and thus conveyed to the mind;—the Eye is only the medium or outward instrument. You point a Telescope towards an object; but, it is not the instrument which sees;—it is you who look through it;—so it is with the Eye.

If a certain portion of the Brain becomes diseased, or injured, blindness will ensue, although the Eye and its Nerve continue healthy. It is singular how we possess the power of Internal Vision, whilst we are actually asleep.

It may be urged by some—How can matter alone possess the faculty of Vision? But, if this be not the case, what must be our conclusion? We can only regard it as a phenomenon of the mind, and not of the material framework; for without the existence of that essential immaterial principle—the mind,—Vision could in no wise be produced. The Structure of the Brain and of the Optic Nerve—exquisitely delicate as that Structure is, is infinitely too gross to render them anything more than the material agents through which the mind, and through which Vision,—one of its properties,—is manifested. Thus we are enabled, from the contemplation of this faculty alone, to perceive that something more is requisite for sensation, perception, and Intelligence. There is a principle superadded to the material organization, which, in the Brain, gives perception and thought, Vision and feeling, and all other modifications of sensation, which are exercised and made manifest through the different organs of the senses. Perhaps, this is all the explanation which can be given of the matter.

It is this developement of the mind, through the material organization,—that gives to man what he possesses of the Divine nature;

hence, the fire that sparkles in the Eye,—the animation that lights up the human countenance,—the commanding dignity of form,—the god-like and erect attitude of his whole bearing.

The Eyes of most vertebrate or invertebrate animals, are constructed, as has endeavoured to be shewn, on the same optical principle as that which has been described in reference to the human Eye,—viz., on the principle of the Camera Obscura,—with dioptric parts for collecting the diverged rays to foci. The eyes of certain others of the invertebrate animals,—viz., insects, and crustaceous, are, for the most part, constructed on a principle altogether different,—that of receiving the *central* rays of the cones of light, from the different points of the field of view, by so many Eyelets, arranged together in the direction of the radii of a common sphere, and excluding the *divergent* rays of the cones, instead of making use of them by collecting into a focus.

Eyes, constructed on the latter plan, do not require any adjustment for different distances, nor any modification of the form of their dioptric parts according to the medium—air or water,—in which the animal lives. Eyes constructed on the former plan, on the contrary, require not only adjustment for different distances; but, also modifications of the form of the dioptric parts to adopt them to the medium in which the animal lives.*

Let us now proceed to give an explanation of the projection of Images on the table of the Retina;—this may be readily understood, if we only reflect how they are painted on the screen of the Camera Obscura. Any one can see for himself how beautifully the image of an object is formed on the Retina;—if he will take the fresh Eye of an ox, or a sheep, and remove a portion of the Sclerotic and Choroid

* When we are viewing near objects, and those afar off, it is astonishing with what rapidity the Eye adjusts itself, with what accuracy and precision! How this is effected has remained a vexed question with Physiologists; it has generally been thought some change takes place in the position of the Crystalline Lens, it is pushed forward, or drawn backward, by some mechanical action of the Globe. We find such an adjustment necessary in the tube or Lens of a Telescope.

investments at its back part;—when by directing the Cornea towards any object,—a lighted candle, for instance,—he will see a small *inverted* picture of the object shining through on the exposed Retina. A similar demonstration may be given on the Eye of a white rabbit, without doing anything more than cleaning the posterior surface of the Sclerotica.

It is a law of light, that its rays, as long as they continue in the same medium, proceed in straight lines. The pencil of rays diverging from the various points of external objects,—those only which fall on the transparent Cornea, and are transmitted by it to the Aqueous Humour, and thence through the Pupil to the Retina, are concerned in Vision. Those rays which fall on and pass through the circumferential part of the Cornea, are stopped by the Iris, and are either reflected, or absorbed by it. The effect of the refraction by the Cornea, and of that by the different humours on the rays, is to make them converge.

The Eye then being regarded as an optical instrument, the light strikes upon the transparent Cornea, and refraction takes place,—that is,—the rays which have touched upon its convex surface, or reflected towards it from surrounding objects, are bent inwards;—they penetrate this transparent tunic and enter the Aqueous Humour in the Anterior Chamber,—here they begin their convergence,—that is—they begin to incline towards each other,—and are perfected in the Lens—they are concentrated.* When the rays have been thus perfected, or drawn to a point in the Lens,—they afterwards cross each other, and passing through the concave Vitreous Humour,—divergence takes place,—that is—they separate, or divide,—they are projected upon the bottom of the Eye—the Retina,—and thus a distinct Image of the object before us is beautifully painted there; an accurate Image—a perfect transcript of Nature by her own hand.

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* An explanation was given by reference to a Coloured Drawing.

How astonishing all the diversified objects we are surveying,—whether terrestrial, or otherwise,—are represented on so small a screen as the Retina,—a surface not larger than a shilling! How can an extensive landscape of several miles,—the stupendous mountains which rise on mountain,—or the numberless bodies which glitter in the firmament above,—be painted so exquisitely, and on so diminutive a tablet?

Again, we are struck with amazement, when we contemplate the fact,—that, although we see everything in Nature as it really appears, whether we are engaged in surveying some vast and charming landscape;—or whether we are admiring the objects most which immediately surround us,—the cloud-capped towers,—the gorgeous palaces,—the solemn temples,—the craggy rocks, and flowery fields,—the ebbing water, and everything that can charm the Eye,—these are transferred in the most beautiful, yet accurate size, with all their glowing tints, on the Retina,—the tablet prepared for their reception; not, however, in the manner they would seem to appear to us; but, in an *inverted* position,—their order is completely reversed. How is this? It is simply owing to the rays of light crossing in the Lens; so that those which pass from the lower part of an object, are presented uppermost at the bottom of the Eye, and vice versa. This is precisely the case in the Camera.

In order that accurate Vision may be effected, it is necessary that there exist a certain correspondence in form, between the several humours;—if this be not the case, there must be imperfect or confused Vision; if the Cornea, or Lens be too convex, there is near-sitedness,—because, the picture cannot reach the bottom of the Eye, owing to the rays of light becoming converged *anterior* to the Retina. Let a person, however, with this defective sight, make use of a pair of concave glasses, and the evil is at once remedied;—near and distant objects are viewed distinctly, by the aid of these mechanical contrivancies—artificial Lenses.

It might seem an extraordinary circumstance that birds of prey are enabled to see at such great distances ;—this, however, depends entirely upon their having a small flat Crystalline Lens, and a very large concave Vitreous Humour. This fact may be noticed, for instance, in the Eye of the eagle, &c.*

But, we will take another case of imperfect sight,—some people are long-sighted ;—what is the reason ?—Solely because the Lens is not sufficiently convex ;—consequently, the rays of light are concentrated too far back,—that is, *beyond* the Retina ; therefore, no distinct image can be painted without the assistance of an external convex Lens. What indeed is a Telescope without a focus ? Precisely is this the case with the Eye.

Several present, perhaps, may be ready to ask why persons advanced in years require the aid of glasses ? Clearly, it is not owing to the want of sufficient light on the Retina ;—it arises from an alteration in the Lenses of the Eye. As we advance in age,—beyond a certain period, our muscular frame begins to decline, and thus it is with the Eye ;—in short, we have approached that stage of life, when the windows begin to be darkened,—the keepers of the house begin to tremble, and the strong men bow themselves. There are several instances, however, where no such aid we have been speaking about, is required,—the Eye having preserved its integrity to extreme old age.

Having now briefly explained to you how the image of an object is represented on the tablet, or bottom of the Eye, I will endeavour to point out the use of the dark coloured substance on the surface of the Choroid Investment. Its use then is for the same reason that the Optician, after he has constructed his Camera, or Telescope, finds it necessary to paint its walls black. After the rays of light have passed through the Pupil to the Retina, all the superfluous rays

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* See Illustration.

are absorbed by this dark coloured secretion,—those which would otherwise create confusion,—and consequently disturb the perfection of Vision, by their reflection in the interior of the organ,—false images would be formed;—this would precisely be the case,—whether in the Eye, or with the Telescope;—all imperfection, however, is prevented by the black lining in the one, and the dark secretion in the other;—thus the picture is painted without false lines or colours.

Did time allow, a few words might be said on the Sensibility of the Eye; we can only remark, after what has already been stated about the Iris, that an excess of light is equally painful to the sensitive condition of the organ, as it is injurious to vision;—most of us have, more or less, experienced this, under a cloudless sky, or from the glare of a meridian sun. Were it not, however, for the Iris and Eyelids, which defend the Eye from too great an excess of light, the painful sensation would be ten-fold,—we could never look on strong light,—we should only be able to dwell in comparative darkness.

Having extended our remarks thus far, a distinguished writer observes, "We cannot fail to notice, that had man been destitute of the noble faculty of Vision, the rest of creation being the same,—what a barren wilderness this glorious world would have been! In vain the enlivening beams of the sun would have darted from that fiery orb;—in vain the beautiful and variegated appearance everywhere present through the agency of those beams;—in vain the smiling landscape;—the colours of the rainbow;—the blue sky, and spangled heavens;—the undulating hill and dale;—the green verdure;—the beautiful plumage of birds;—and more than all,—the expressive countenance of his friend;—All these and a thousand other beauties which tend to cheer him, and to display the boundless power of God,—would have remained unnoticed, and been created in vain;—since, without Vision they could not have been made apparent to his perceptive faculties."

In drawing, therefore, to a conclusion, it requires but little argument to convince us that the loss of so invaluable a blessing as that of sight, is indeed an evil which no one can really know, but he who unfortunately experiences such a sad bereavement. Listen to MILTON, who has given vent to his feelings in the most desponding and dolorous terms;

O why was sight
To such a tender ball as the Eye confined,
So obvious, and so easy to be quenched;
And not, as feeling, through all parts diffused,
That she might look at will through every pore?

Again, this Prince of English Poets, in somewhat more subdued, but equally pathetic terms, utters his sublime verse;—

Not to me returns
Day, or the sweet approach of ev'n or morn;
Or sight of vernal bloom, or summer's rose;
Or flocks, or herds, or human face divine;
But cloud instead, and every during dark
Surrounds me,—from the cheerful ways of men
Cut off, and for the book of knowledge fair
Presented with an universal blank.

Again, in the beautiful plaint of the Poets' Samson Agonistes, Milton felt the grief he sung, and the manner in which he describes the loss of Vision, is of the most touching kind;—

O loss of sight! of thee I most complain.
Blind amongst enemies. O worse than chains,
Dungeon, or beggary, decrepid old age!
Light, the prime work of God, to me is extinct,
And all her various objects of delight
Annull'd, which might in part my grief have eas'd.

Inferior to the vilest now become
Of man or worm;—the vilest here excel me.
They creep, yet see. I, dark in light, exposed
To daily fraud, contempt, abuse and wrong,
Within doors, or without, still, as a fool,
In power of others, never in my own;
Scarce half I seem to live, dead more than half.
O dark, dark, dark! amid the blaze of noon
Irrecoverably dark, total eclipse
Without all hope of day!
O first created beam! and thou, great word,
'Let there be light!' and light was over all;
Why am I thus bereaved thy prime decree?
The sun to me is dark
And silent as the moon
When she deserts the night
Hid in her vacant interlunar cave.

The countenance of man, however, may be deformed in the loss of Vision, when the exterior of the Eye is defaced by an extensive pearly appearance of the Cornea,—generally the result of small pox, or neglected inflammation, which all must have seen; or where the organ shrinks back through disease, or accident. Here, I take this public opportunity of remarking, there is no censure too great, which can be passed on those parents who obstinately persist in their refusal to have their children vaccinated;—it is as much a duty on their part, as it is to educate and provide for them. How many a beautiful face has been marred through life, frequently too with loss of sight, by small pox! I do not hesitate to declare my firm conviction, that were every infant properly vaccinated with healthy lymph at a certain age,—from three to six months old,—this malignant scourge would, sooner or later, be banished from the land.

Even where the front of the Eye, however, remains in its normal or perfect condition,—if the Retina or Optic Nerve becomes affected

by disease, as in the case of Milton,—Vision is destroyed;—the organ in this instance, presents a dull and inexpressive appearance. The Poet's Eyes were beautifully bright and clear, to all external appearance; still he saw not the light, because the Nerve of Vision had lost its power and function through disease,—his Eyes had become amaurotic, and he thus graphically describes their actual condition;—

> These Eyes, though clear
> To outward view, of blemish, or of spot,
> Bereft of light, their seeing have forgot;
> Nor to their idle orbs doth sight appear
> Of Sun, or Moon, or Star throughout the year!
> Or Man or Woman!

As we are at this moment describing the pitiable condition of one whose sight had been exchanged to darkness,—irrecoverable darkness,—let us glance at a few of the other causes of blindness.—We have seen that Milton's—a very common case,—resulted from paralysis of the Retina or Optic Nerve, so there could be no communication to the Brain of external objects.* The Retina, however, may continue perfect and healthy,—yet the front of the Eye shall be marred by disease, as by the pearly appearance already alluded to, or destroyed by accident. What then? Vision cannot take place because the rays of light cannot penetrate the Cornea in the former instance. You will frequently hear it said, such a person has a "*kell*" over his Eye! There is no such word in the English language—grammatically and correctly speaking—unless it be derived from the Greek, κηλη, which means a tumour,—and this I imagine cannot be the case;—when this expression is used, it simply means a film or

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* During the hours of sleep, the images of objects are painted on the bottom of the Eye the moment the lid is raised to admit the rays of light; but, volition being suspended, the mind does not take cognizance of them. Probably in Milton's case, there was the picture on the Retina, but the Brain did not receive it.

speck on the surface of the Cornea, whereby the rays of light are more or less obstructed from entering.

Passing by other diseases to which the Eye is liable, I will proceed to explain to you the nature of CATARACT,—another, and a very frequent cause of blindness,—since there may be several present who are unacquainted with its true character. Cataract is a disease of the Crystalline Lens, whereby it loses its transparency, and refuses to permit the rays of light to pass through it,—so that no picture will be painted on the Retina,—however perfect in its functions this membrane may be, because, you will recollect, the Opaque Lens is placed between the Retina and the object intended to be viewed. As well might you attempt to count the figures on the dial of a watch, when a piece of paper, or any other opaque body is placed over the transparent glass.

There are several kinds of Cataract, which it will not be now necessary to particularize;—happily, however, in most instances, sight can be given, or restored by the submission to a simple surgical operation.—The diseased Lens has been extracted by an opening made in the transparent Cornea;—or it has been removed from the axis of Vision and left in the Vitreous Humour. A more simple operation, however, consists in introducing an instrument into the Eye;—breaking up the Lens, and leaving it *in situ* to be dissolved in the Aqueous Humour, which possesses this singular property.—Some children are born blind with this disease of the Lens,—and perfect sight has been given by an operation of this kind. An infant born in this state possesses the faculty of distinguishing light, without the power of taking cognizance of a single object, and is almost as bad off as if he had no Eye at all. If, however, at a certain period the opaque body is removed by an operation,—what a glorious world presents itself before him,—a sort of new creation takes place! We must not forget, however, sight is a faculty which is not acquired in an instant, it is not intuitive,—but, requires exercise, or training, as

well as speech and hearing. Shakespeare has put this sentiment into the mouth of one of his characters (Glo'ster) in his reproof of an imposture who pretended to have been restored to sight by a miracle.

> If thou had'st been born blind,
> Thou might'st as well know all our names
> To name the several colours we do wear.
> Sight may distinguish colours;
> But *suddenly* to nominate them all,
> It is impossible.

Amongst several cases which might be brought forward as a proof of the remarks I have made, I will briefly relate the case of a boy born blind, on whose Eyes I operated a few years ago. After sight was given him, he could not tell anything by seeing it,—he knew nothing of colour,—and for a length of time was unable to distinguish a single object, except by touching it;—moreover, the Eyes of such a person, for want of due exercise, acquire a habit of constantly rolling about. A distinguished surgeon, with a view to cure this incessant rolling, has lately attempted the division of the several muscles which move the organ, in the case of a young lady, where the operation had sadly been deferred;—there would arise an objection, however, to such a course I think, because in that case, Vision could only be *directly forward*. CHESELDEN, the celebrated Surgeon, had a parallel case to my own. After the lad, on whom he had operated, had received his sight,—he could not distinguish colours;—a small miniature was shewn to him of his father;—he

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The first case of Cataract which came under my own treatment, occurred in the village of Ruddington;--it was an interesting one. Mrs. Shaw had been blind for many years from Cataract;--she was the mother of a numerous family, and had not seen *two* of her children in consequence of her blindness. I operated on both Eyes,--Vision was completely restored in each, and my patient not only had the gratification of seeing *all* her children; but, by the aid of proper Lenses, she was enabled to read the smallest type, as well as sow the smallest needlework. Mrs, S. lived in the enjoyment of her restored sight during nearly thirty years, and died only a few months ago.

said, it resembled him very much; "but," he asked with great astonishment, "how it was possible for so large a visage to be kept in so small a space? As that appeared to him as impossible as that a bushel could be contained in a pint!"

Other interesting cases might be brought forward to illustrate our subject; but to prolong the Lecture might prove tedious;—I have endeavoured, however, to condense as much matter to make the subject, which has been brought before you, as pleasing and interesting as I have been able, and by the aid of models and drawings, intelligible;—thus, my task has been nearly completed. We have seen wisdom and design displayed in the adaptation of the Eye to light;—we have witnessed it in the construction and arrangement of the Lenses, so as to produce images of objects;—we have traced it in the Structure of the coats of the Eye,—the one beautifully transparent,—the other rendered carefully opaque, and protecting the delicate textures which they surround;—we have observed it in the dark pigment spread out upon a fine membrane lining the inner surface of the Globe, for the very pnrpose of absorbing superfluous light,—thereby insuring the perfect representation of images;—it has been rendered apparent in the curtain placed across the chamber of the Eye,—endowed with a power of expanding and contracting its aperture, according to the varying intensity of light and shade;—and it has been equally manifest in the placing the Retina in the precise part of the Eye where the images are formed, and thence carried to the Brain,—the centre of intelligence. We have also seen the evidence of design, in the complicated arrangement of the Muscles and Nerves of the Eyeball;—in the offices of the Eyelids;—in the various Glands and Ducts connected with the Organ;—as well as in the refined sensibility of the Eye to external impressions.—We have seen it in other instances which have been classed in our Lecture. What now remains, therefore, but that we dwell for a few moments on the future destiny of the Organ!—the thought is a delightful one to the reflective and pious mind. Amidst the great mass of

animated beings which inhabit this lower earth, Man alone, after he has shaken off the coil of mortality, is destined for a new era of existence,—to outlive the wreck of matter, and the crash of worlds. Yes,—Empires shall fall into ruin and decay: but, man shall live beyond these,—he shall exist for ever;—his spirit having emanated from HIM who hath created all things, and upholdeth them by the word of his power, he cannot die; but shall come forth from the tomb renewed and quickened into life;—the holy Patriarch of old knew this;—he knew, that after his frail body had gone down into its original element,—the dust of the earth,—and after the pageantry and mockery of this sublunary state had for ever passed away,—he should with his OWN Eyes SEE his Maker and Almighty friend. Amidst bereavements and sufferings and trials of the severest and most painful description,—in the triumphant language of Faith, hear him exclaim,—"I know that my Redeemer liveth, and at the latter day he shall stand upon the Earth, and though after my skin worms destroy this body, yet, IN MY FLESH SHALL I SEE GOD, WHOM I SHALL SEE FOR MYSELF, AND MINE EYES SHALL BEHOLD, and not another,." How, or in what manner Vision will be exercised in a future state of bliss, I do not presume to hazard an opinion,—the question is surrounded with clouds and mystery;—but, not a single doubt remains, that in the Resurrection body, all who shall be admitted into that happy world of light and glory, for which Man was originally created, shall have Visual enjoyment,—for we are assured, by the unerring standard of Eternal Truth, that EVERY EYE SHALL SEE, and we shall KNOW even as we are known. There might be ample proofs brought forward from Holy writ, of this glorious doctrine, were this the fit time and place to enter more fully on the subject; but, I pause. The Infidel and the Sceptic may vauntingly demand "how can these things be?"—Nevertheless, it shall even be so;—if it were not,—how, in the Resurrection state shall we, who now see darkly through the dim vista of time and sense, then be able to SEE FACE TO FACE? And where would be that future MUTUAL RECOGNITION which the true

Christian so much desires and ardently anticipates ? * It must be so, else,—why such fortitude and resignation under pains and suffering and trial, and whence that pleasing hope, that longing after immortality ?

> But, faith reveals to mortal Eyes
> A brighter world beyond the skies,

where all sin and suffering shall for ever be cast away ;—the mighty engines of war shall cease their roar,—the din and clash of arms, which now vibrate and disturb the land, shall be hushed ; and all shall be love, joy, and peace, without alloy ;—for—"The Lamb, which is in the midst of the Throne, shall feed his chosen ones, and shall lead them unto fountains of living waters ; and God shall wipe away all tears from off all Eyes."

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* John Martin, the distinguished painter, in his magnificent picture of the Last Judgment, has, with a grandeur of conception and design, exquisitely portrayed several touching scenes of this description, amongst the Saints which have just risen from their tomb, and shaken off the dust of death. The whole conveys a lesson of great solemnity, mingled with joy.

Mr. Martin's three sublime pictures were exhibited in Nottingham and Leicester a few months ago, and are to be engraved from.

THE END.

JOHN HENRY GRAY, PRINTER, MARKET-PLACE, LOUGHBOROUGH.

I HAVE not entered into the subject of Spherical Aberration;—Chromatic Aberration;—Distential Aberration;—Outness of Vision; &c.—This rather belongs to the Law of Optics, and might form the substance of a future Lecture.