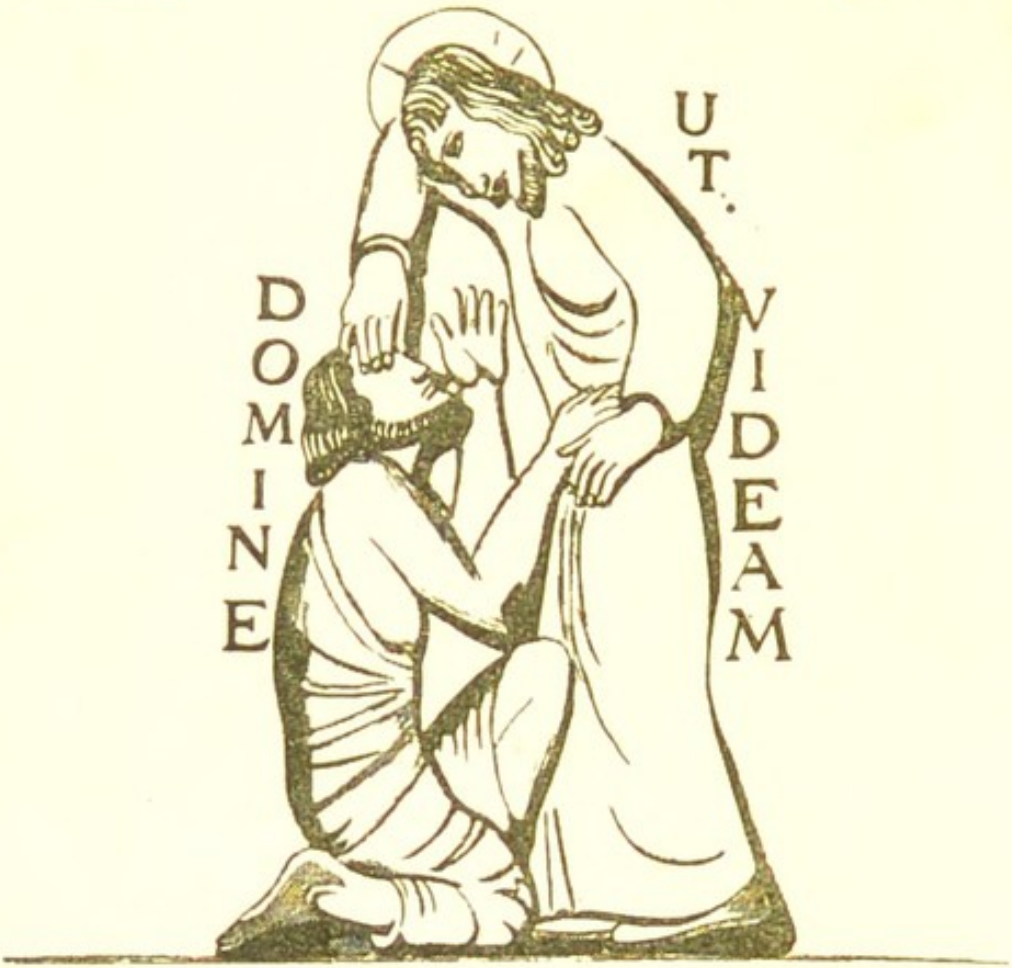
The principles and practice of ophthalmic surgery : comprising the anatomy, physiology and pathology of the eye, with the treatment of its diseases / by Benjamin Travers and Joseph Henry Green, edited by Alexander Cooper Lee.

OPHTHALMIC SURGERY.

TRAVERS & GREEN.



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THE

PRINCIPLES AND PRACTICE

OF

OPHTHALMIC SURGERY.

G. WOODFALL, ANGEL COURT, SKINNER STREET, LONDON.

THE

PRINCIPLES AND PRACTICE

OF

OPHTHALMIC SURGERY.

COMPRISING

The Anatomy, Physiology, and Pathology

OF

THE EYE,

WITH THE TREATMENT OF ITS DISEASES.

BY

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MDCCCXXXIX.

TO

RICHARD D. GRAINGER, ESQ.,

LECTURER ON ANATOMY AND PHYSIOLOGY AT THE THEATRE OF ANATOMY AND MEDICINE, WEBB STREET, MAZE POND,

THIS LITTLE BOOK

IS MOST RESPECTFULLY INSCRIBED,

AS A TRIFLING ACKNOWLEDGMENT FOR THE MANY ACTS OF KINDNESS AND REGARD

WHICH HAVE BEEN CONFERRED

ON HIS OBEDIENT SERVANT,

A. C. LEE.

PREFACE.

WHOEVER ventures to add a new book to the stock already in existence, is bound to show good and sufficient cause for such an addition. In the present instance, having no pretension to originality of matter, my sole aim has been to present to the reader, in what I conceived to be the most convenient form, every point of importance connected with the subject under consideration.

The book consists of Two Parts: the first of which embraces the Anatomy and Physiology of the Eye; while the second is devoted exclusively to its Diseases, and their Treatment. To apologize for the introduction of a description of the structure and physiology of the Eye, into this book, will, I imagine, be needless. To those who are sticklers for precedent, the excellent work of Mr. Travers will suffice; but were no such example in existence, I should still hazard its introduction, as I consider that an examination of its structure and physiology ought to go hand in hand with the investigation of its diseases; and he who is thoroughly conversant with its anatomical structure, will be able to treat the various affections of its tissues on the same general principles which guide him in the treatment of similar affections in other parts of the body.

In the formation of the First Part, I have selected the best descriptions from every accessible source, altered the language wherever it seemed necessary, and arranged them in the manner which seemed best calculated to form a clear and connected account of the Structure and Physiology of the Eye.

The Second Part, which is devoted exclusively to the Pathology and Treatment of Diseases of the Eye, has for its basis some very clear and concise lectures that were delivered by Mr. Green, at St. Thomas's Hospital, on the subject in question, and which convey a great deal of information in a very small compass. The arrangement has been somewhat modified, and additions have been made from the works of Lawrence, Travers, and Guthrie, where any deficiency was observed.

The sources from whence I have drawn the materials for this book are the works of Messrs. Travers, Harrison, Mayo, Müller, Brewster, Lawrence, Green, and Guthrie.

Such is a sketch of the contents of this little book; which is offered to the notice of the Medical Profession, from a desire to place within the reach of all, the means of studying the structure, functions, and diseases of, perhaps, the most important organ of the human frame, while many of the most valuable works on the subject are inaccessible to the many from their costliness or scarcity. Should it meet with a favourable reception from the Profession, I shall derive as much satisfaction from this little compilation as if I had gained a portion of that more lasting renown which usually attends the production of an

original work, from the conviction, that he, who facilitates the approach to the fountain of knowledge, who communicates that to the *many* which before was only known to the *few*, is entitled to almost as large a share of praise as he who adds fresh links to the chain of human knowledge.

A. C. L.

Three Crown Square, Southwark.
October 20th, 1838.

CONTENTS.

ANATOMICAL DESCRIPTION OF THE EYE AND ITS APPENDAGES.

PHYSIOLOGY OF THE EYE AND ITS APPENDAGES.

THE PATHOLOGY AND TREATMENT OF THE DISEASES OF THE EYE.

AN

ANATOMICAL DESCRIPTION

OF

THE EYE

AND ITS APPENDAGES.

THE eyes, or organs of vision, are contained in two somewhat irregular funnel-shaped or pyramidal cavities, situated on either side of the root of the nose, and immediately under the arch of the forehead.

ORBITS.

These cavities are denominated the *Orbits:* which have their apices looking backwards and inwards, and their bases outwards and forwards. The axes of the two orbits are, consequently, oblique lines, which posteriorly converge, and decussate about the sella turcica, anteriorly, on the contrary, they diverge; an arrangement by which the field of vision is greatly extended.

Their Parietes.

The walls of each orbit are formed by seven bones; namely, the frontal, the sphenoid, æthmoid, lachrymal, maxillary, palate, and malar bones. The upper wall or roof of the orbit, which is formed by the orbital plate of the

frontal bone, and the lesser wing of the sphenoid, is concave, presenting anteriorly depressions for the lachrymal gland and the trochlea, and posteriorly assisting in the formation of the optic foramen. The floor of the orbit is nearly plane, and inclines downwards and outwards; it is formed by the malar, superior maxillary, and palate bones; the infra-orbital canal extends along its under surface, transmitting vessels, which freely anastomose with the ophthalmic, and a nerve from which the inferior palpebra derives its chief supply. The external or temporal wall is formed by the malar and sphenoid bones, and diverges considerably. The internal or nasal wall is formed by the lachrymal, æthmoid, sphenoid, and palate bones; it is plane and nearly parallel with its fellow of the opposite side. Anteriorly, the base of the orbit is formed by the frontal, the malar, and superior maxillary bones.

Their Foramina.

The foramina opening into this cavity are numerous. Anteriorly in the base of the orbit there are four, viz., the *supra-orbital*, for the transmission of the supra-orbital or frontal nerve; the *infra-orbital*, for the transmission of vessels, and a nerve from which the inferior palpebra derives its chief supply; the *malar*, for the passage of a branch from the lachrymal nerve, to communicate with the facial nerve; and the *nasal duct*. Within the orbit there are five foramina; namely, the *optic*, for the transmission of the optic nerve and ophthalmic artery; the *foramen lacerum orbitale superius*, for the transmission of all the nerves except the optic, and the ophthal-

mic vein; the *spheno-maxillary fissure*, for the passage of the spheno maxillary nerve; and two *internal orbital foramina* in the suture connecting the frontal and æthmoid bones, for the transmission of vessels and nerves, the anterior one transmitting the nasal division of the ophthalmic nerve.

Contents of the Orbit.

The contents of the orbit are the eye and its appendages, imbedded in a quantity of adipose substance. These appendages may, for convenience of description, be further divided into *orbital appendages*, which are situated posterior to the cornea; and *facial appendages*, which are placed anterior to the cornea.

FACIAL APPENDAGES.

THE SUPERCILIUM, OR EYEBROW.

The arch of the eyebrow corresponds to that of the superciliary ridge upon which it is planted. It extends from the tuberosity of the frontal sinus to the external angle of the orbit. It consists of a thick row of strong short hairs, which have a disposition almost erect at the commencement of the brow, and are then arched obliquely outward, and gradually reduced in number so as to terminate the arch acutely. The few erect hairs correspond to the fibres of the corrugator supercilii muscle, the crescentic to the fibres of the orbicularis palpebrarum.

The extent and fulness of the brows vary greatly in different persons. In some, especially persons of dark complexion and black hair, they have little, if any, inter-

space at their origin, and are long, prominent, and bushy in the centre of the arch. Among the ancients these were esteemed points of female beauty. The fibres of the occipito frontalis, or epicranial muscle, terminate beneath the skin of the supercilium, blending with those of the orbicular muscle of the palpebra. The former elevates the brow, wrinkling the integument of the forehead horizontally; the latter depresses it, and closes the eyelids, being the sphincter palpebrarum.

The *corrugatores* approximate the heads of the supercilia, drawing the integuments over the root of the nose into deep longitudinal rugæ: they cooperate with the orbicularis in the act of frowning. The action of the subjacent muscles renders the brow an important feature in regulating the quantity of light, contracting the field of vision, and in assisting the expression of the sterner passions. It would not be a useless ornament if it were insusceptible of motion, the hair being advantageously placed upon the projecting ridge of the orbit to entangle and arrest particles, solid and fluid, which might otherwise fall or trickle upon the eye. The habitual depression of the brow is usually a concomitant of a weak or morbid retina; it is characteristic of strumous inflammation, and is observable in all cases where light is offensive, and in those central circumscribed opacities of the cornea and lens, in which the dilated state of the pupil is necessary to vision.

EYELIDS.

The palpebræ, or eyelids, are those semi-oval curtains which cover the great aperture of the orbit, and graduate

the light falling upon the eye by the degree of their separation, or exclude it by their apposition. They consist of the *skin* externally, the *conjunctiva* membrane internally, and between the two are placed the *orbicular muscle*, *tarsal cartilage*, and *Meibomian follicles*; and lastly, along the free edge of each there are a row of hairs, which are denominated *ciliæ*, or *eyelashes*: in the superior there is also the expansion of the levator palpebræ muscle. The skin covering the palpebræ is thin, and loosely connected to the subjacent parts by a fine lax cellular texture, which abounds at the orbitar margins of the palpebræ. The frequent œdema of the eyelids, so disfiguring to the countenance, is owing to the abundance of this tissue void of fat, and subject therefore to serous infiltration.

Orbicularis Muscle.

On removing the skin and the subjacent cellular tissue of the palpebræ, the thinly spread fibres of the *orbicularis muscle* may be observed; broad, thin, and somewhat oval, in some subjects very pale and indistinct, in others strong and well marked; it *arises* from the internal angular process of the temporal bone, and from a tendon at the inner angle of the eye, by a number of fleshy fibres which pass round the orbit, covering first the superior and then the inferior eyelid, and also the bony edges of the orbit: it is *inserted* by a short round tendon into the nasal process of the superior maxillary bone. This muscle is covered by and adheres to the skin; superiorly it intermixes with the occipito frontalis, and covers the corrugator supercilii, the frontal vessels and nerves, the tar-

sal cartilage, and levator palpebræ superioris ; inferiorly it intermixes with the muscles of the cheek and lips, and sometimes with the platisma myoides, and covers the inferior eyelid, the origin of the levator anguli oris, and the infra-orbital vessels and nerves. The external or orbital fibres of this muscle are strong and red, and run circularly round the base of the orbit ; the middle or palpebral fibres are pale, thin, and scattered, and are contained in the eyelids ; the internal or ciliary portion is a thick but pale fasciculus, situated under the ciliæ, at the edge of each eyelid. The palpebral and ciliary portions adhere more closely to the skin, and present an elliptical appearance, as the fibres from the upper and lower eyelid intersect each other at the outer canthus, and adhere to the ligament of the external commissure. The horizontal tendon of this muscle passes across the lachrymal sac, a little above its centre, and a strong aponeurosis, derived from its upper and lower edge, covers all the anterior surface of the sac, and adheres to the margins of the bony gutter, in which it is lodged. This tendon can be seen or felt through the integuments during life, particularly when the muscle is in action, or when the eyelids are drawn towards the temple. In the operation of opening the lachrymal sac, the incision should commence immediately below this tendon, and be carried obliquely downwards and outwards, to the extent of about half an inch.

THE INNER CANTHUS.

The *inner canthus*, formed wholly of the doubling of the integument, is that notch, or triangular sinus,

formed between the *tarsi* and the tendon of the *orbicularis* muscle.

TARSAL CARTILAGES.

The *tarsi* are two elliptical, elastic plates of cartilage, which give firmness and figure to the palpebræ, and afford a basis for the attachment of their several parts. The superior is semi-lunar and larger than the inferior, which is long and narrow. Their ciliary margins are thick: their orbital margins thin, and connected to the orbit by the palpebral ligaments, which are a continuation of the periosteum; these ligaments are stronger towards the temple, where they decussate and attach the cartilages at their external canthus or commissure; the tendo oculi fixes them internally. Their temporal extremities are angular, their nasal rounded. The convex surface of the tarsi is covered by the fibres of the orbicularis and the cellular membrane, connecting them with the integument; the concave, which is exactly moulded to the surface of the globe, is covered by the conjunctiva membrane.

EYELASHES.

The exterior borders of the sloped edges of the tarsi, which are opposed to each other, are furnished with *cilia*, or *eyelashes*, disposed in three or four rows; these we may therefore call the ciliary borders of the tarsi. The apertures in which their bulbs are contained, are seen in the integument when the cilia are extracted; they are more numerous and longer upon the centre than the extremities of the tarsal arch, and fewer and shorter on the

lower than the upper tarsus. Their direction is curved, those from the upper being arched upwards, from the lower downwards. The length and fulness of the eyelashes vary in different individuals. They are commonly of the same colour as the eyebrows.

FOLLICLES OF MEIBOMIUS.

Upon the interior border of the tarsus the mouths of a row of follicles, seated vertically on the concave surface of the tarsus, form a slightly eminent line. These follicles are of a white or yellow colour, are arranged in nearly parallel vertical rows, and are more numerous in the upper than the lower eyelid; when magnified, they appear to be small knotted tubes, resembling studs of the smallest pearls, arranged for the most part in parallel lines, and communicating with each other at their origin from the orbitar edges of the tarsi, but terminating by distinct orifices upon their interior borders, which we may distinguish from the ciliary as the Meibomian borders of the tarsi. In their length, connexion, and arrangement, they present considerable variety. The fluid they secrete in health is thin and sebaceous, lubricating the tarsal edges, preventing the effects of attrition from their frequent contact, and facilitating their motions over the contiguous surface of the globe. In diseased states of the follicles, this fluid may be secreted in a condensed form, or after death in the shape of small white worms.

PUNCTA LACRYMALIA.

The obliquity of the tarsal edges, which are opposed to

each other, leaves a groove, or sulcus, between the Meibomian borders and the surface of the globe, when the ciliary borders are in contact. This increases in breadth toward the nasal angles of the tarsi, where the *puncta*, or orifices of the lachrymal excretories, are placed upon two small eminences accurately opposed, and terminating the Meibomian borders ; they are two pinholes formed in the cartilaginous substance, and thus preserved permanently open.

LACHRYMAL DUCTS.

The *lachrymal ducts* extend from the puncta to the lachrymal sac ; the superior is longer and more curved than the inferior ; the former is concave inferiorly ; the latter is nearly straight, a little concave upwards ; they both open into the external part of the sac, a little above its middle, sometimes by one, and sometimes by distinct orifices, behind the *tendo oculi ;* each duct is surrounded by a process of that tendon, and lined by mucous membrane.

LACHRYMAL SAC.

The *lachrymal sac* is a small oval pouch of mucous membrane, closed above, and leading below into the nasal duct ; it is situated in a fossa formed by the anterior concave portion of the os unguis, and the nasal process of the superior maxillary bone on which it rests ; in front it is covered by the skin, the tendo oculi, some fleshy fibres of the orbicularis, and a strong fascia which is derived from the tendon, and connected to the surrounding bony margin. On its outer side there is an opening for

the reception of the lachrymal duct; and below it terminates in the nasal duct. A small muscle has been described by Mr. Horner as *arising* from the edge of the os unguis, and inserted into the lachrymal sac and duct, which he conceives to have the power of compressing the sac, and directing the ducts and their contents towards it; it is not, however, in all subjects, to be distinguished from the orbicular, which last can effect the purpose ascribed to this small muscle.

NASAL DUCT.

The *nasal duct*, which is the continuation of the lachrymal sac, and is about three-fourths of an inch in length in the recent state, descends obliquely backwards and a little outwards, surrounded by the maxillary, unguis, and inferior spongy bones; beneath the latter it opens by a small slit-like orifice, which is surrounded by a circular fold of mucous membrane, into the lower meatus, about an inch from the anterior part of the naris; this duct is formed of mucous membrane only; it is connected to the periosteum.

The puncta absorb the tears, which have been conducted by the tarsi from the lachrymal ducts, and convey them into the sac, to pass off by the nasal duct.

CONJUNCTIVA.

The integument of the eyelids is inflected at the edges of the tarsi, and lines the whole of the concave surfaces of the palpebræ; is reflected upon the visible face of the globe, enters into the puncta, lines the lachrymal sac, and at the nasal extremity of the duct is continuous with

the common mucous membrane of the nostrils, fauces, and alimentary canal.

The conjunctiva, having lined the interior surfaces of the tarsi, is connected to the ligaments of the tarsi and palpebral muscles, and thence reflected on the globe of the eye, so as to form an oblong sac or pouch. Its attachment to the sclerotic is such as to prevent its forming folds in the motions of the globe, to the freedom of which it offers no impediment. As it approaches the cornea, its attachment becomes more strict, and at the margin of that membrane it is inseparable from it. Its continuity is ascertained by dissection, but its tenuity and transparency are increased, and when held to the light it has a nearer resemblance to a very delicate lamella of the cornea than to the conjunctiva of the sclerotic. After maceration, the separation is more readily effected.

Its continuity demonstrated by Disease.

The character of this membrane is so materially modified by its several relations with the integument, the tarsi, the sclerotic, and the cornea, that its continuity alone establishes its identity. The fact of this continuity is, however, corroborated by some pathological phenomena, which so often illustrate problematical points in anatomy and physiology. For example, the conjunctiva furnishes the matrix for the adventitious vessels, which are created to repair breaches of the corneal texture. These vessels, whether formed by the healing process, or opened by long continued diseased action, as in chronic ophthalmia, are obviously superficial. The circumstances by which they are produced, are characterized by

different appearances, as I shall hereafter point out. Again, when a small portion of the conjunctiva is abraded by an extraneous particle, the scabrous surface of the cornea is exposed, and ulceration of this surface ensues. The deficiency of the conjunctiva is exactly depicted by the margin of the abrasure, and the contrast of the surfaces. This is very dissimilar to the interstitial ulcer of the cornea. The pterygium, a rare disease, exhibits the continuity in a very striking manner. It has a full broad base next the canthus, where the conjunctiva lies loose, and is gradually flattened and drawn to a point, so as to have a wedge-like form as it approaches the cornea. But although the deposition is beneath the conjunctiva, it does not stop at the cornea, but slowly travels across it. The strictness of this adhesion alters its appearance ; the lymph, shed between the conjunctiva and cornea, presenting only a progressive dense opacity, instead of the fleshy elevation which it exhibits upon the sclerotic. The continuity of the superjacent texture is demonstrable.

Upon the tarsi the membrane is closely adherent, and although transparent, appears of a pale red tint ; upon the sclerotic and cornea it is colourless. The sclerotic conjunctiva, however destitute of red vessels in the tranquil state of the organ, becomes conspicuously vascular and acquires a deep red colour by inflammation, its minutest capillaries appearing to convey red blood in the vehement acute ophthalmia. Those of the corneal conjunctiva are only to be seen when, by a continued distention, the connection is loosened between the conjunctiva and cornea. In this case, the cornea exhibits red

vessels freely inosculating from its opposite sides, and anastomosing with each other. The increase in number and extent of these vessels is a gradual process, demonstrable to observation; and the inflammatory action which precedes this state is ordinarily of considerable duration. The incapacity of the vessels of the corneal conjunctiva to receive red blood, seems to depend upon the strictness of its adhesion.

Valvula Semilunaris.

The conjunctiva is attached to the canthi of the eyelids, and, at the internal canthus, forms a semi-lunar duplicature in the shape of a valve. The horns of this crescentic fold are lost in the sinus palpebralis, or angular fold of the conjunctiva.

Caruncula Lachrymalis.

On the fore part of this valve, a small red glandular body, *caruncula lachrymalis*, is seen, occupying the hollow of the canthus. The caruncula is a granulated substance, of a conical form and a deep red colour. The base of the cone is next the orbit, the apex towards the eye. A few fine hairs are scattered over its surface. It is made up of a congeries of minute follicles, secreting that mucus which accumulates during sleep in the form of a gummy matter, at the inner corner of the eye; and appears to perform a similar office to that of the Meibomian glands, which are confined to the tarsi.

From the above description it will be understood, that the palpebra, the anterior hemisphere of the eyeball, and the lachrymal passages, are every where covered by the

reflected integument, modified in its disposition and qualities as its economy requires, which invests the organs of sense, the hollow viscera, and forms the external covering of the body. It is by the continuity of this membrane that the sympathy is established between these surfaces, healthy and morbid, remote and contiguous, and that the diseases with which they are affected have for the most part a common character.

VESSELS OF THE EYELIDS.

A superior and inferior branch, derived from the ophthalmic artery, at its egress from the orbit, course along the orbital edges of the tarsi, and form by inosculation at the external angle, a complete *arcus palpebralis*. A superciliary arch is also formed by the union of the superciliary artery, from the ophthalmic, with the temporal. The nasal branch of the facial artery assists in forming these arches, and freely communicates with the frontal branch of the ophthalmic. The superior coronary, transverse facial, infra-orbital and temporal artery, participate in the supply of the palpebræ.

The VEINS, beginning by small radicles from the opposite margins of the tarsi, form an intricate plexus beneath the skin of the palpebræ, and are collected into the facial, supra-orbital, and deep temporal vein. The arteries pass in the direction of the orbicular fibres; the veins cross them at right angles; their direction varying according to the breadth of the palpebræ.

NERVES OF THE EYELIDS.

The nerves take a direction similar to the veins, the

frontal branch of the fifth pair supplies the superciliary and superior palpebral branches; and the infra-orbital, or first branch of the superior maxillary nerve, gives off three principal branches, which turn round the trunk of the facial vein, to be dispersed upon the lower eyelid.

PECULIARITIES OF THE UPPER AND LOWER EYELIDS.

Thus far, the anatomical structure of the eyelids has been generally described; there remain some peculiarities which are now to be examined. The superior is broader than the inferior palpebra, covering two-thirds of the surface of the globe by its descent. It is also more moveable, the inferior palpebra being inconsiderably elevated to meet it in shutting the eye. The superior palpebra, when drawn up, makes a doubling or deep crescent-shaped fold in the skin under the orbitar arch, which is effaced when the palpebra falls. Upon the skin of the lower eyelid narrow and gently curved rugæ are seen; these, which are signs of the unequal contractility of the skin and the muscular fibres beneath it, are more strongly marked in persons of advanced years, in whom the muscles have been longer and more rigorously employed, and whose skin is loose or redundant from the absorption of the adeps beneath it.

The parts next in order that we have to examine are the

ORBITAR APPENDAGES.

PERIOSTEUM.

The walls of the orbit are lined by a process of the

dura mater, which, passing out of the cranial cavity, gives a periosteal covering to the bones of the orbit, and becomes continuous at all its openings with the periosteum of the head and face; hence the extensive sympathetic pains in inflammatory affections of the bones of the face and cranium, and their common membrane. Hence also probably the suppurative inflammation of the dura mater, after extensive fractures and injuries of the orbit.

FAT.

The fat, which in health is secreted abundantly in the orbit, surrounds the optic nerve, and invests the posterior surface and sides of the globe, forming for it a soft bed, and defending the vessels and nerves from compression in its motions. In emaciating diseases its diminution by absorption produces that characteristic sinking of the globe in its socket, and loss of convexity in the eyelid, which is familiarly expressed by the term "hollow-eyed." On the other hand, its secretion in excess, as in morbid obesity, protrudes, compresses, and thus induces congestion in the vessels of the eye.

The muscles of the orbit are seven in number; viz., the levator palpebræ; the rectus superior, inferior, internus, and externus; obliquus superior and inferior.

LEVATOR PALPEBRÆ.

The levator palpebræ is the highest muscle in the orbit; it *arises* narrow and tendinous from the upper edge of the foramen opticum, passes forwards and outwards beneath the frontal nerve, and becoming broader, bends down in front of the eye; it then ends in a dense cellular expan-

sion, which is *inserted* into the superior border of the tarsal cartilage and into the superior palpebral sinus of the conjunctiva, behind the palpebral ligament. *Use*, to elevate and retract into the orbit the upper eyelid. From the nature and extent of its connection with the eyelid, it results that the partial division of the tarsal ligament, or even the removal of the cartilage, does not take awa y the power of elevating the lid, as the paralysis of th s muscle does ; the elevation, however, under these circumstances, is imperfectly performed.

The *recti* muscles are four in number ; the *superior* or *attollens oculi*, the *inferior* or *depressor oculi*, the *internal* or *adductor oculi*, and the *external* or *abductor oculi*.

RECTUS SUPERIOR.

The *rectus superior* is broad, thin, and tendinous at its extremities, and fleshy in the rest of its extent ; *arising* from the border of the foramen opticum and the partition between it and the foramen lacerum ; inserted into the sclerotic, about a quarter of an inch behind the cornea. The *superior* surface of this muscle is covered by the levator palpebræ ; the *inferior* is placed upon the optic nerve, the ophthalmic artery, and the nasal branch of the ophthalmic nerve, anteriorly upon the eye itself. This muscle raises the eye.

RECTUS INFERIOR.

The *rectus inferior*, similar in structure and figure to the preceding, *arises* from a ligament which in part surrounds the foramen opticum, and fills up the foramen

lacerum ; and is *inserted* like the preceding in the sclerotic. The *inferior* surface of this muscle is separated from the floor of the orbit by adipose tissue ; the *superior* is in connection with the optic nerve, a branch of the third pair, and the eye. The action of this muscle is to draw the eye downwards, and consequently it is an antagonist to the *superior*.

RECTUS INTERNUS.

The *rectus internus* is similar in its figure and origin to the preceding, and is inserted, on the inner side of the eye, into the sclerotic. The action of this muscle is to draw the eye towards the nose.

RECTUS EXTERNUS.

The *rectus externus* arises by two distinct heads : the *inferior* having a common origin with the *rectus internus* and *inferior*, from the ligament which occupies the inferior angle of the foramen lacerum ; the *superior* from an arch of ligament crossing the foramen above. It is inserted into the outer part of the sclerotic coat. Its action is to roll the globe of the eye outwards. It is important to note this bicipital origin of the rectus externus, as some of the nerves of the orbit pass through the interspace between its heads, and others through the top of the foramen.

SPHENO-MAXILLARY LIGAMENT.

The ligament of the foramen spheno-maxillare forks into three intermuscular slips, which give origin and sup-

port to the external, inferior, and internal recti muscles, in the manner of the intermuscular ligaments of the extremities.

ACTIONS OF THE RECTI.

The single actions of the *recti* are expressed by the terms, levator, depressor, adductor, abductor. Their co-operation retracts the globe in its socket.

SUPERIOR OBLIQUE.

The *superior oblique* muscle, situated at the upper and inner part of the orbit, *arises* at the upper and inner border of the foramen opticum, whence it proceeds forward along the os planum, and ends in a slender round tendon, which passes through a half ring of cartilage that is attached by a ligament to the os frontis, a little above and behind its internal angular process. This *trochlea* is provided with a sacculus mucosus, and the tendon emerging from it is enclosed in a ligamentous sheath ; this tendon is then reflected backwards, outwards, and downwards, between the superior rectus and the eye, and then becoming broad and thin, is *inserted* into the sclerotic coat between the superior and external recti ; about midway between the entrance of the optic nerve and the insertion of the superior rectus. The *action* of this muscle is to draw the eye forwards and inwards, also to rotate it, so as to direct the cornea downwards and inwards towards the tip of the nose. Some authors consider it a rotator outwards.

INFERIOR OBLIQUE.

The *inferior oblique*, situated at the inferior and an-

terior part of the orbit, *arises* tendinous from the orbital edge of the superior maxillary bone, above the infra-orbital foramen, and external to the lachrymal sac; it ascends obliquely outwards and backwards, below the inferior rectus, and is inserted by a tendinous expansion into the sclerotic coat behind the transverse axis of the eye, and between the sclerotic coat and the external rectus. Its action is to draw the globe forwards and inwards, and to rotate it upwards and outwards. The two *oblique* muscles acting together draw the eye forwards and inwards, consequently they are antagonists to the *recti*.

ARTERIES OF THE ORBIT.

The ARTERIES of the eye are principally derived from the ophthalmic artery, which *arises* from the internal carotid, close to the anterior clinoid process, passes forwards through the optic foramen, below the optic nerve and external to it; in the orbit it rises above this nerve and twines round it to the inner side of this cavity, along which it passes to the inner canthus, where it terminates. The branches it gives off in its course are, while on the outer side of the nerve,—

1st. *Centralis retinæ*, very small, it pierces the sheath of the optic nerve, passes along the centre of the latter into the eye, where it divides into delicate ramifications; these spread along the internal layer of the retina, one or two pierce the vitreous humour, and extend to the capsule of the lens.

2d. The *lachrymal* passes along the external rectus muscle, and supplies the lachrymal gland, and the external part of the palpebræ.

The branches given off by the ophthalmic artery above the optic nerve, are,—

3d. The *supra-orbital*, which passes forward along the levator palpebræ, and through the superciliary notch, supplies the muscles and integuments of the eyebrow, and ascending on the forehead divides into several branches, which are distributed to the scalp, and communicate with the temporal and occipital arteries.

4th. The *posterior ciliary*, ten or twelve in number, are very small, they surround the optic nerve, and pierce the back part of the sclerotic; pass between it and the choroid, and are distributed to the latter; some of their branches continue as far as the ciliary processes and the iris.

5th. *Long ciliary*, one on each side; they pass horizontally forwards, between the sclerotic and choroid membranes, as far as the ciliary circle; here they divide, and form a circular inosculation round the circumference of the iris; from this several branches radiate inwards, and again unite in a circle near the pupil.

6th. *Muscular arteries*, to the different muscles in the orbit.

The branches given off by the ophthalmic artery in its course along the inside of the optic nerve, are,—

7th. *Ethmoidal arteries*, they pass through the posterior orbitar foramen to the mucous membrane in the æthmoid cells.

8th. *Superior* and *inferior palpebral* arteries to the palpebræ, caruncula, conjunctiva, and lachrymal sac.

9th. *Nasal*, passes beneath the trochlea, along the side of the nose, and inosculates with the labial artery.

10th. *Frontal*, which ascends to the eyebrow and forehead.

VEINS OF THE ORBIT.

The veins of the orbit correspond to the arteries, and are all collected into the ophthalmic vein in its passage through the orbit. It takes a serpentine course over the optic nerve, through the foramen lacerum, to terminate in the anterior part of the cavernous sinus of the dura mater.

The NERVES of the orbit are the *optic nerve;* the third pair or *motores oculorum;* the fourth, or pathetici; the *ophthalmic division* of the fifth; and the sixth or *abducentes.*

OPTIC NERVE.

Each optic nerve, on passing through the optic foramen, becomes surrounded by a strong sheath derived from the dura mater; the four recti muscles next surround it, from the fleshy portions of which it is separated by a considerable quantity of soft fat, in which several nerves and vessels are lodged; from the optic foramen this nerve proceeds forwards and a little inwards, so as to be slightly curved, the convexity outwards; at the back part of the eye, it is very much constricted; it then pierces the sclerotic and choroid membranes, and terminates in the retina. In addition to the dura mater, this nerve possesses a very dense neurilema, which sends in numerous processes to form small canals or tubes in which the nervous

substance is contained, so that this nerve is not composed like other nerves, of several filaments placed parallel to each other; if the white substance be removed by maceration in an alkali, its cellular structure will become obvious.

SITUATION OF THE NERVES IN THE CAVERNOUS SINUS.

In the cavernous sinus at the side of the body of the sphenoid bone, the four nerves of the orbit are arranged in their numerical order, viz. most superiorly the third pair, then the fourth, next the ophthalmic division of the fifth pair, and most inferiorly the sixth or abducens nerve; in this part of their course, they are so closely united together, that they are sometimes called the *orbitar plexus;* when, however, they arrive at the anterior clinoid process, they separate, and as they enter the foramen lacerum orbitale, their arrangement is as follows; most superiorly the *fourth*, then the *frontal* branch of the ophthalmic, next the superior division of the third, external to which, and near to the outer wall of the orbit is the *lachrymal* branch of the ophthalmic, after these the *nasal* nerve, below which is the *inferior division* of the *third*, and lastly, lying inferior to them all is the *sixth*, holding the same relation to them as at the cavernous sinus.

THIRD PAIR.

The *third pair* enter the orbit in company with the nasal branch of the fifth and the sixth pair, and divides into two branches. Its *superior* or *lesser* branch divides into two branches, the smaller and shorter one of which

supplies the superior rectus, the other the levator palpebræ muscle. The *inferior* or larger branch passes below and to the outside of the optic nerve, and divides into three branches; the *internal* is the largest, it passes obliquely downwards, forwards, and inwards, beneath the optic nerve, and getting to its internal side is distributed to the internal rectus; the *middle* supplies the inferior rectus; and the *external*, which is the longest, passes downwards and forwards on the surface of the inferior rectus, between it and the globe of the eye, (it gives off no filaments to this muscle,) and is lost in the inferior oblique muscle; besides these branches the *inferior division* of the third pair gives off from its root a small short filament to the ophthalmic ganglion. All the branches of the third pair are distributed to the *ocular* surface of the muscles.

FOURTH PAIR.

The *fourth pair*, called also *trochleator* or *patheticus*, enters the orbit by the foramen lacerum, ascends obliquely forwards and inwards above the levator palpebræ and the superior rectus, and is distributed by four or five fine branches to the upper surface of the superior oblique muscle: as this delicate nerve is passing along the outer side of the cavernous sinus, it lies between the third pair and the ophthalmic branch of the fifth, below the former and above the latter and the sixth; as it enters the orbit it mounts above the third and fifth; and is therefore the highest nerve in the orbit, both it and the frontal being immediately beneath the periosteum; previous to entering the oblique muscle its size is somewhat increased.

OPHTHALMIC DIVISION OF THE FIFTH PAIR OF NERVES.

The *fifth pair*, or *trigemini*, having formed the semilunar or gasserian ganglion, divides into three branches; the *ophthalmic*, the *superior* and *inferior maxillary* nerves.

The ophthalmic nerve passes along the outer side of the cavernous sinus below the third and fourth, and above the sixth, in this situation it receives some filaments from the sympathetic nerve; as it approaches the foramen lacerum orbitale, it divides into three branches, the *lachrymal*, *frontal*, and *nasal*.

Lachrymal Nerve.

The *lachrymal nerve*, the smallest of the three, passes forwards and outwards to the lachrymal gland, above the external rectus muscle and beneath the periosteum; in this course it is surrounded by fat and accompanied by the lachrymal artery; it gives off two small branches, one through the spheno maxillary fissure to communicate with the superior maxillary nerve, and the other through the malar bone, to communicate with the facial nerve; it then enlarges, sends four or five branches to the inferior surface of the lachrymal gland, and terminates in several fine soft filaments on the conjunctiva lining the superior palpebra, and the cellular membrane between the gland and malar bone.

Frontal Nerve.

The *frontal nerve* enters the orbit between the superior rectus and the periosteum, along with the fourth, but inferior and external to it; it passes forwards in a kind of

groove on the upper surface of the levator palpebræ muscle ; and near the superciliary arch it divides into two branches, an *external* and *internal*. — The *internal* or supra-trochleator nerve is the smaller branch, and runs forwards and inwards above the trochlea of the superior oblique muscle, and is distributed to the corrugator supercilii, orbicularis palpebrarum, and occipito frontalis muscles, also to the integuments of the forehead and superior eyelid ; it communicates with the nasal nerve, and sends one or two small filaments into the frontal sinus.—The *external* branch, called also the *supra-orbital* or the *proper frontal* nerve, from its size and direction, appears to be the continuation of the original trunk ; it passes through the superciliary notch or foramen, ascends on the forehead, divides into two branches which subdivide into numerous filaments ; these chiefly ascend in the muscles and integuments of the scalp, many of them take a very long course, and communicate with the portio dura, with the occipital nerves, and with those from the opposite side. The ophthalmic nerve gives no filaments to the muscles of the orbit.

Nasal Nerve.

The *nasal nerve* separates from the frontal behind the orbit, enters this cavity beneath that branch, and between the two heads of the external rectus, it then runs obliquely forwards and inwards above the optic nerve, and below the superior rectus muscle, and continues its course along the inner side of the orbit, below the superior oblique muscle, and then divides into branches, the *external* or *infra-trochleator nerve*, and the *internal* or *proper nasal*

nerve. Before it enters the orbit, the nasal nerve frequently receives a filament from the sympathetic nerve; just as it enters the orbit, and on the outer side of the optic nerve, it gives off a delicate filament, about an inch in length, which runs along the outer side of the optic nerve to the lenticular ganglion; as the nasal nerve passes over the optic it gives off two ciliary nerves. The *external* or *infra-trochleator nerve* passes out of the orbit, beneath the trochlea of the superior oblique muscle, and is distributed to the lachrymal passages and dorsum of the nose. The *internal* or *proper nasal nerve* reenters the cranium by the anterior internal orbitary foramen, and from thence again passes down through one of the perforations of the cribriform plate of the æthmoid bone, to be distributed to the septum narium and the nasal fossæ.

SIXTH NERVE.

The *sixth* or *abducens nerve*, after traversing the cavernous sinus, where it is joined by branches from the sympathetic nerve, on the outer side of the carotid artery, enters the orbit through the lower part of the foramen lacerum between the origins of the external rectus beneath the other orbital nerves and above the ophthalmic vein; it then passes forwards and outwards, and is distributed to the ocular surface of the external rectus muscle.

OPHTHALMIC GANGLION.

The *ophthalmic ganglion* is a small body situate near the back part of the orbit, between the optic nerve and external rectus muscle; it is of a reddish colour, and sur-

rounded by soft fat; its posterior superior angle receives the filament before mentioned from the nasal branch of the ophthalmic, and its posterior inferior angle receives the twig from the inferior oblique branch of the third pair; these two nerves are described by some as forming this ganglion; from the anterior angles of this ganglion two fasciculi of fine nerves proceed, termed the *ciliary;* the inferior fasciculus is larger than the superior; the ciliary nerves are about twenty in number, eight or ten in the inferior fasciculus, about six in the superior, and three or four internally, which arise from the nasal nerve; the ciliary nerves twine along the surface of the optic nerve, accompanied by the ciliary arteries, and pierce the back part of the sclerotic coat, they then become flat, and proceed forward in parallel grooves on the inner surface of that membrane, with very little connexion, to the choroid coat; at the anterior part of the eye they meet the ciliary ligament; in this substance most of these nerves are lost, hence some consider this as a ganglion; on each side, however, one or two branches may be traced through this into the iris, in which they divide into numerous filaments of extreme minuteness.

FUNCTIONS OF THE NERVES OF THE ORBIT.

The functions of the nerves of the orbit are as follow: the optic nerve is specially destined for vision, the third, fourth, and sixth are for communicating motion to the muscles of the orbit, and the ophthalmic branch of the fifth pair is for communicating sensation to the parts within and around the orbit; the office of the lenticular

ganglion will more properly come under consideration hereafter.

LACHRYMAL GLAND.

The *lachrymal gland* is situated within the orbit, at its upper and outer part, beneath the fossa in the orbitar plate of the frontal bone, and behind its external angular process. It is about the size of a small almond, and will readily be discovered, either by dividing the integuments of the upper eyelid, and then dissecting towards the cavity of the orbit, between the upper tarsus and the supra-orbitary ridge, or by dividing the conjunctiva uniting the upper tarsus to the eye, and then drawing the eye a little forwards. The gland is a yellowish white body, of an oval flattened figure, divided by a cleft into two lobes, of which the superior and internal is the smaller and thinner, the inferior and external the large extremity of the gland. Its position is oblique; the inferior and internal surface hollowed to suit the convexity of the globe; the superior convex, to suit the corresponding concavity of the orbit, to which the gland is attached by a ligament passing transversely beneath it. It measures in length about ten lines; in breadth five or six. In structure it is conglomerate, consisting of numerous small granular portions, or lobules, connected together by dense cellular tissue, upon which its vessels and nerves ramify, to supply the granules of which it is composed. The vessels enter the gland posteriorly, and from the anterior margin, its ducts, five or six in number, pass out in straight lines, and pierce the conjunctiva at the orbitar edge of the superior tarsus.

Having now examined the structures of the facial and orbital appendages, let us next proceed to the investigation of the anatomy of

THE GLOBE OF THE EYE.

SITUATION.

The eye is situated at the anterior and internal part of the orbit, behind the conjunctiva, surrounded by muscles and fat, and connected anteriorly to the eyelids by the conjunctiva, posteriorly retained in its place by means of the optic nerve.

SIZE.

The size of the eye varies but little in different individuals. The apparent difference arises either from the difference in the degree of projection of the eye in different individuals, a circumstance which is determined by the relative volume of the ball and its socket ; or from variations in the form of the eyelids, and in the diameter of the opening between them. When this opening is wide, a large extent of the eye is exposed, and the whole organ seems to be large and project forwards. The small size of the opening between the lids produces the opposite impression. When paralysis affects the palpebral muscle of one eye, the organ, compared with its fellow, has the appearance of being diminished in bulk.

SIZE IN THE FEMALE.

The eye of the female is commonly smaller than that of the male; and the fissure of the eyelids, which are

rounder, broader, and more delicate in texture, is generally less.

FIGURE.

The figure of the eye is such that it represents portions of two spheres of different diameters. The posterior four-fifths of the organ is the larger sphere, while the anterior fifth is a section of a smaller sphere. The *eye*, therefore, is not exactly spherical, the *antero-posterior*, or visual axis, which is nearly an inch, being about one or two lines greater than the transverse or vertical axis. The visual line is parallel in the two eyes.

COMPOSITION.

The eye is composed of fluids or humours enclosed in different membranes ; these membranes are,—

1st. The cornea.
2d. The sclerotic.
3d. The iris.
4th. The choroid and its appendages, the annulus and processus ciliares.
5th. The retina.

The fluids are,—

6th. The aqueous humour.
7th. The crystalline humour.
8th. The vitreous humour.

The cornea is the anterior transparent membrane which first converges the rays of light.

The sclerotic is the external fibrous opaque investiture of the choroid.

The iris is the coloured membrane in which the aperture termed 'the pupil' is formed.

The choroid is the vascular membrane of the eye, and the dark screen which confines and condenses the rays of light. Its appendages are auxiliary to this purpose, and to other parts of the economy of vision.

The retina, or nervous coat, is the membranous expansion of the optic nerve, upon which the images of external objects are painted.

The humours give shape to the eyeball, and support its tunics.

The crystalline is set in the vitreous humour, and washed in front by the aqueous humour.

SCLEROTIC COAT.

The *sclerotic coat* is the external covering of the eyeball, with the exception of one-fifth part, bearing a proportion to the cornea somewhat similar to that which the vitreous bears to the aqueous humour. It is a strong, opaque, fibrous membrane, extending from the optic nerve to the cornea, which preserves the globular figure of the eye, defends its more delicate internal structures, and serves as a point of insertion for those muscles which move the eye. About a line internal to its centre posteriorly, it is perforated by the optic nerve; this is a small conical aperture, which appears traversed by fibres, so as to present a cribriform appearance; it is doubtful, however, whether this indistinct appearance may not partly depend on the central vein and artery of the retina, which accompany the nerve through this opening; the sheath of the optic nerve is continuous with this

membrane. Anteriorly it receives the cornea, and is so intimately connected with it, that maceration alone can separate them; both are sloped off obliquely as well as slightly grooved; the sclerotic overlaps the cornea, and their connexion is still further secured by the conjunctiva externally, and by the membrane of the aqueous humour internally. The sclerotic, around the entrance of the optic nerve, and likewise around the margin of the cornea, has many small oblique passages, of which the apertures on its internal surface are conspicuous when separated from the choroid, for the entrance and exit of the ciliary vessels and nerves. In structure it is dense and fibrous, these fibres presenting, on maceration, a reticulated appearance: it has few nutrient vessels, and no traceable nerves; its texture is both extensile and elastic. In the fœtus and infant it admits of separation into two plates or layers, but these are inseparably connected in the adult. Externally, the sclerotic is of a blueish-white colour, and rough. Internally, it is smooth and glistening; it has also furrows in right lines, in which the long ciliary vessels and nerves are lodged. Throughout the greater part of their extent, the sclerotic and choroid coats are loosely connected together through the medium of blood vessels and cellular tissue; but around the opening through which the optic nerve passes, the union between these two membranes is more firm. The density of the sclerotic is not uniform; a vertical section of this membrane from behind forwards, will show its greatest density to be posteriorly near the optic nerve, where it is about a line in thickness, and it becomes gradually thinner towards its front margin, where it is again

strengthened by the tendinous expansion of the recti muscles. Its thickness varies a little in different persons; being occasionally so thin immediately around the cornea, as to permit the blackness of the choroid to be seen through it.

CORNEA.

The cornea forms the anterior fifth of the external membranous covering of the eye; it is nearly circular, its transverse diameter being a little greater than its vertical. The anterior or convex surface is covered by a fine and closely adhering membrane, which, though generally considered a continuation of the conjunctiva, is very different from it in its structure and properties. The posterior or concave surface of the cornea is lined by a fine elastic membrane, which, by some, is described as a part of the membrane of the aqueous humour; it is however a membrane *sui generis*; it is best seen in the eye of the horse which has been macerated for some days; the external laminæ, which are now opaque, can be peeled off, leaving behind it this elastic cornea, which preserves its proper curve and transparency; if it be cut, it will curl up in itself, thus exhibiting true elastic cartilaginous properties. The structure of the cornea is horny, less extensile than the sclerotic, and perfectly transparent. It is onion-like, composed of concentric lamellæ or pellicles, connected by a delicate cellular tissue containing a transparent fluid, in which exhalant and absorbent vessels are abundantly distributed. This tissue is more lax or copious between the anterior than between the posterior lamellæ. The transparent conjunctiva upon the cornea, gives a polish and brilliancy to the

surface, which the lamellæ of the cornea do not possess, and which is lost at the approach of death, by the transudation of the aqueous humour. They are scabrous from the adhesion of the cellular membrane connecting them, and void of lustre.

The cornea is of greater thickness than the sclerotic in infants, in whom its posterior surface is contiguous to the iris. The internal surface is likewise half a line broader than the outer, the margin being obliquely extended from without inwards, to correspond with the sloped edge of the sclerotic. After maceration, it may be detached from the sclerotic, to which it is connected by cellular tissue; this separation is most readily effected by plunging the macerated eye into boiling water. A fine transparent humour is secreted by colourless exhalants in the areolæ of the cellular membrane between the lamellæ of the cornea. The interstitial substance of the cornea receives no coloured vessels. Numerous lines have been observed to form figures of many sides between the plates of the cornea in the eye of the negro, and supposed, from a reddish tinge, to be blood-vessels. The existence of nerves has never been demonstrated, and it is much to be doubted if it possess any. The convexity of the cornea is greater than that of the sclerotic, being the segment of a sphere seven lines and a half in diameter.

CHOROID COAT.

The next membrame we have to examine is the choroid, which is exposed in the following manner: fix the eye in a small shallow vessel, which can be readily immersed under water, carefully raise a small portion of the sclerotic,

pass in some air between it and the choroid, these membranes can thus be readily separated ; then dissect off the sclerotic under water ; this tunic can be readily detached as far as the cornea, here it adheres to the *ciliary* ligament ; this connexion may be separated with the handle of the knife, the cornea or one half of it, may also be removed with the sclerotic, and the next tunic of the eye will be exposed, the *choroid*, with its appendages, the ciliary ligament, ciliary processes, and iris.

The *choroid membrane* extends from the circumference of the optic nerve to the margin of the exterior or flattened surface of the vitreous humour, there it terminates, together with the retina, in a greyish coloured substance termed ganglion, or ligamentum ciliare, or better, annulus ciliaris, and which is the common centre of union for the interior membranes of the eye.

The external surface of the choroid is of a dusky brown colour in the adult, reddish in infants, and adhering by an abundant and lax cellular tissue, which may be readily inflated, to the sclerotic coat, and by the numerous ciliary vessels and nerves which perforate the latter to take their course upon the choroid. This cellular substance is more plentiful in the infant than the adult, and is most abundant in the track of the principal vessels and nerves. The vessels terminating upon it are extremely numerous, and secrete a dark pigment, or varnish, which stains the contiguous adhering surface of the sclerotic ; it likewise communicates its stain to the fingers, or a piece of white paper, but the texture of the membrane is permanently dark, and is not bleached by maceration.

The internal surface of the choroid is also covered with

a black varnish, thicker and deeper coloured in the infant than in the adult; but having no connexion by texture to the retina, its stain is not communicated to that membrane. Around the insertion of the optic nerve, the choroid is destitute of this dye. Residence for some time in alcohol discovers a fine white flocculent substance coating the interior of the choroid, formerly described by Ruysch as a distinct membrane, (*tunica Ruyschiana*,) but not regarded in this light by modern anatomists. The pigment, there can be no doubt, is secreted into a fine cellular tissue, flakes of which are detached in some diseased states of the organ, from the ciliary processes and back part of the iris, forming to all appearance a real membrana nigra.

Nerves and Vessels of the Choroid.

The ciliary nerves run in parallel lines, at equal distances, upon the choroid; and from their equal size and whiteness are particularly conspicuous. The long ciliary arteries appear, one on either side of the globe, in their course to the annulus ciliaris. Beneath these the membrane presents, on its opposite sides, vessels arranged in the form of trees with weeping branches, or of the figure of a jet d'eau; these, which have been named vasa vorticosa, are veins returning the blood distributed to the ciliary processes, and are collected into three or four distinct venous trunks. The short posterior ciliary arteries pass under the ciliary veins, in the intervals of the trunks, to the interior of the choroid; and uniting with the anterior at the fore part of the globe, their extremities form a very intricate and beautiful net-work upon its interior surface. The adhesion of the choroid to the sclerotic is most strict, ad-

jacent to the optic nerve posteriorly, and the ciliary ring anteriorly, owing to the introduction of the ciliary vessels at these parts. This membrane is more dense anteriorly than posteriorly.

CILIARY LIGAMENT.

The *ciliary ring*, or *ligament*, is an elastic ring, composed of a short and dense pulpy texture, closely adherent to the inner border of the sclerotic, at the distance of a line and a half from the external circumference of the cornea. It is of greater breadth on the temporal than on the nasal side. The choroid and retina adjoin its greater, the cornea and iris its lesser circumference. Anteriorly it adheres firmly to the sclerotic, as before observed, and the ciliary processes are attached to its posterior surface, so that it forms a common centre of union for these tunics. Its colour is observed to correspond to that of the iris.

CILIARY PLAITS OR PROCESSES.

On the internal surface of the choroid, at the root of the ciliary ligament, the plicæ or processus ciliares arise in delicate striæ, and advancing a little anterior to the circumference of the crystalline lens, terminate in a circle of fine grey points at the base of the iris. They appear to be radiated folds of the choroid coat, from sixty to seventy in number, long and short alternately, and gathered at their origin like the plaits of a shirt at the wrist-band. Viewed collectively through the vitreous humour, they have some resemblance to a radiated flower ; a small white circle appears within a large dark one. The white lines represent the edges of the plicæ ; the black, their in-

terstices coated with pigment. These edges of the plicæ are engrooved in the duplicature of the vitreous capsule, which assists in forming the canal of Petit.

The extremities of the processes projecting from the interior border of the annulus ciliaris interdigitate with the radical fibres of the iris. To obtain a view of them, let the cornea be accurately removed at its junction with the sclerotic, and the iris be torn away, entire, from its ciliary attachment. The points of the processes will then appear, projecting like the teeth of a comb from behind the annulus ciliaris; and the ciliary border of the iris, upon floating it in water, will be found to present a corresponding arrangement.

The processes having their edges thus inlaid in the tunica hyaloidea at the margin of the crystalline fossa, and their points or anterior extremities interlaced with the radicle fibres of the iris, form a posterior iris, the aperture of which is exactly occupied by the crystalline lens and its capsule. From their origin to their insertion, they are supported exteriorly by the annulus ciliaris, with which substance they are in fact incorporated. The figure of each plica ciliaris is triangular, the internal obtuse angle being opposed to the circumference of the crystalline lens; the posterior, elongated, loses itself in the choroid; the anterior is inserted into the iris. The anterior edge is attached to the annulus ciliaris and root of the iris, the posterior to the tunica hyaloidea, and the internal and shortest measures, the space between the verge of the crystalline lens and the basis of the iris; or in other words, forms the outer boundary of the posterior chamber.

THE IRIS.

The *iris* is a delicate, circular, coloured membrane which presents a plane surface traversing the globe vertically, and dividing the corneal from the sclerotic segment. It is rendered imperfect as a septum by the pupilla or round hole in its centre. The pupil is not, however, quite central in relation to the iris, the breadth of the iris being always somewhat less on the nasal than on the temporal side. It is divided into a ciliary and pupillary portion. Its attachment is, as already observed, by indenture with the extremities of the plicæ choroideæ, at the inner margin of the annulus ciliaris, from which it originates. The ciliary portion of the iris is the larger one, and is composed of a delicate fibrous and vascular tissue, in which grey serpentine lines or striæ are seen proceeding like radii from the ciliary ligament; from this the smaller pupillary portion is distinguished by a darker shade of colour, and a gently elevated circular line, most conspicuous on the posterior surface of the membrane. The fibres of this portion of the iris have a similar tortuous direction, and are convergent towards the pupillar aperture. The pupillary margin is thin and defined, and presents the appearance of a dark circular line when placed upon a white ground, as e. g. the opaque capsule of the crystalline lens. The iris diminishes in thickness from its base to the margin of the pupil. Its anterior surface is richly coloured of different hues in different individuals. It is thickly coated on its posterior surface by the pigmentum nigrum, which is here called *uvea*.

Vessels and Nerves of the Iris.

The ciliary vessels, entering the anterior part of the globe, unite with the other detachments, and form arches at the base of the iris and processes. From the zone thus produced, (*zona major*,) the branches run in straight lines upon the iris. In the dilated state of the pupil these radiated vessels are tortuous; by its contraction they become straight. At the distance of rather less than half its diameter from the pupil, another zone is formed by their anastomosis, from which branches are detached to the margin of the pupil. The *zona minor* gives the appearance of the undulating circular line, distinguishing the pupillary from the ciliary portion of the membrane. The two long ciliary arteries chiefly contribute to the formation of these zones, and the supply of the iris. The short ciliaries, seen upon the interior of the choroid, detach numerous fasciculi to each ciliary process, which pursue a serpentine course along the fixed edge of the fold, and are inverted to form concentric arches upon its opposite free margin. The nerves which supply the iris, are branches derived from the lenticular ganglion, and nasal nerve.

Membrane of the Pupil.

There is a delicate vascular, which has received the name of membrana pupillaris, that closes the pupil in the fœtus, and is ruptured, either at birth, or a short time previous.

STRUCTURE OF THE CILIARY LIGAMENT.

Of the peculiar structure of the ciliary ligament nothing

certain is known. The notion that it wholly consists of vascular and nervous tissue, having no proper fibrous texture for its base, which has also been conceived of the iris, is absurdly contrary to observation and analogy. The ciliary ligament appears to be a gangliform or bulbous termination of the choroid coat, and the ciliary processes resemble plaits or doublings of this membrane laid back to back, to accommodate it to the area of the posterior chamber.

STRUCTURE OF THE IRIS.

Similar uncertainty prevails as to the structure of the iris, the different opinions of its texture being founded rather upon inference from its functions than upon demonstration. If the former species of evidence be regarded, it is muscular, and accordingly, some anatomists consider it as consisting of two sets of muscular fibres, one *concentric* round the pupil, composed of circular fibres contracting the pupil in the manner of a *sphincter*; the other *radiated*, and having by its muscular action the power of contracting the iris from the centre to the circumference, and consequently enlarging the pupil. Others, again, conceive that the phenomena of its action can be best explained on the supposition that it is both muscular and elastic, and that these forces act alternately.

RETINA.

The *retina*, or delicate membranous expansion of the optic nerve, is situated between the choroid membrane and vitreous humour. It is best exposed by gently tearing off the choroid, the eye being held under water, and then placing an inverted globe filled with clear diluted spirits

over the dissection; the retina will become slightly opaque, and have a magnified appearance. The optic nerve having perforated the sclerotic and choroid coats at the internal and posterior parts of the globe, terminates abruptly in a little white conical eminence or papilla. From the base of this papilla proceeds the very delicate membranous expansion termed *retina*. It encompasses the vitreous humour, the front part only excepted; where, within about two lines of the lens, the nervous matter terminates by an abrupt line, along which a small blood-vessel runs. It is of exceeding delicacy, and on dissection resembles, in semitransparency and in colour, the ground glass of which ornamental lamps are made. During life it is perfectly transparent. Without caution it cannot be preserved entire in dissection; and if, when the sclerotic and choroid coats are divided, the parts of the globe are separated by their weight, by its strict adhesion to the other coats at its origin, it is drawn off the vitreous tunic in the form of a fine medullary rope, which expands and reassumes its proper form in water. The retina is divisible into three layers; first *lamina serosa*, or Jacob's membrane, so called from its discoverer, Dr. Jacob of Dublin, an extremely delicate serous layer which may be separated from the external surface of the retina by gentle pressure with the handle of the knife, under water; second, *lamina nervosa*, which is soft and grey and continuous with the optic nerve; and third, *lamina vasculosa*, which is very delicate, lies on the vitreous humour, and is continued on its fore part to the capsule of the lens, where it becomes adherent to the hyaloid membrane. Dissect off the posterior half of the retina from

the vitreous humour, or cut transversely a fresh eye, and allow the humours to escape, then look on the concave surface of the retina, and we may observe in the centre of the optic nerve a small dark point, the *porus opticus;* this is the central artery of the retina, which then spreads its branches on the internal surface of the retina, in the lamina vasculosa; about two lines external to this, and in the axis of the eye, is a small yellow or orange spot, the *punctum aureum;* the retina is thrown into folds around this. Some describe a perforation and deficiency of the retina at this point, under the name of *foramen centrale*, it rather appears to depend on some peculiar organization. The external surface of the retina is opposed to the choroid, the internal to the tunica hyaloidea.

AQUEOUS HUMOUR.

The name of anterior chamber is given to that space comprised between the cornea and iris, ordinarily about one line and a half in depth. The posterior chamber, not exceeding a quarter of a line, is the space between the iris and the crystalline lens. They communicate by the pupil, and both are occupied by the *aqueous humour.* The aqueous humour is about five grains in quantity, perfectly transparent, having a specific gravity somewhat greater than that of water; it evaporates on exposure to heat, and is uncoagulable by heat, acids, or alkalies; its taste is viscous and slightly saline; in fœtuses and newborn infants, it is turbid, and sometimes of a reddish colour. It gives figure and tension to the cornea, keeps the pupil properly dilated, and supports the parts forming the parietes of both chambers. When discharged by the punc-

ture of the cornea, the pupil contracts, and the chambers are obliterated by the collapse of their parietes; it is however reproduced in a few hours.

VITREOUS HUMOUR.

The *vitreous humour* is the basis upon which the larger tunics of the eye are expanded, and fills a space somewhat exceeding two thirds of the globe of the eye. Upon its anterior surface, it is flattened rather abruptly, and presents a central cup-like depression, the dimensions of which exactly correspond to the posterior segment of the crystalline humour, which is embedded in it. It is a soft, gelatinous, and transparent body, consisting of a thin glairy fluid heavier than water, perfectly pellucid, and contained in cells formed by processes of a delicate membrane, called *hyaloid*, arranged in horizontal planes. Towards the back and sides of the humour these cells are larger than in the interior adjacent to the crystalline fossula; the septa are likewise thicker and stronger towards the circumference of the humour. After a careful section of the frozen humour, its substance may be picked out in solid wedge-like flakes from the interstices of the septa. The continuous covering, though of great tensity and perfect transparency, is of much strength, and resists, owing to the support it receives from the numerous septa internally, a considerable pressure. When lacerated or wounded, the humour of the corresponding cell or interstice is instantly evacuated; but if the wound is superficial, the humour does not escape in quantity, while supported by the other parts of the globe, or if removed from the globe, while suspended in water. But if in any way compressed after a wound, a dribbling of the humour goes on

slowly, until the cells, which communicate with each other, are emptied.

The tunica hyaloidea is covered by the retina in the whole extent of that membrane, but is connected with it only at the entrance of the optic nerve. The substance of the humour is penetrated by a branch of the arteria centralis retinæ, which contributes a few very delicate vessels to its containing membrane. In the fœtus they have been displayed ramifying on the capsule at the back of the lens.

CRYSTALLINE HUMOUR.

The *crystalline humour* is a transparent double convex lens, situated on the fore part of the vitreous humour, behind the anterior third of the eye, and a little nearer to its nasal than its temporal side. Its axis corresponds to that of the pupil, a little to the inner side of the axis of the eye. It measures in breadth about four lines, in thickness about two. The most convex or posterior face of the lens, is exactly fitted to the cup in the fore part of the vitreous humour ; the anterior is opposed to the iris, and the circumference to the canal of Petit. It is surrounded by a proper capsule, which is thin and soft posteriorly, but anteriorly dense and peculiarly elastic. A small quantity of fluid contained in the capsule inclosing the crystalline humour, is called after its discoverer, humor Morgagni. The lens is retained in its place by the hyaloid membrane, which splits into two laminæ at its border ; these laminæ pass, one posterior to the lens, the other before it, and become connected to the proper capsule ; a small triangular canal is formed between these layers, called the canal of Petit, the base of which is formed by the circumference of

the lens. Inflation of this canal shews that it is not of uniform dimensions; like the large intestine, it is tacked up into cells or pouches by short transverse septa, whence the name given by Petit, *canal gauderonné*, or godronne. In the grooves corresponding to these septa, the posterior edges of the ciliary processes are inserted. The intervening looser portions of the membrane correspond to the interstices of the processes; and the black radiated lines, which appear upon the membrane of the canal, are stains left by the pigment which fills them. Like the ciliary ligament, the canal is broader on the temporal than the nasal side. This humour is perfectly transparent in a healthy state. In the fœtus and new born infant, it is spherical, semifluid, and has a slightly reddish tint. In the adult, it is gelatinous in consistency, its external lamellæ easily broken down between the fingers, but a nucleus of greater firmness is formed in the centre, which in some degree resists this pressure. In advanced age, the lens becomes more close and compact in texture, and the nucleus acquires a yellow or topaz colour.

Its texture.

The texture of the lens is lamellated; the lamellæ concentric and connected by a very delicate fibrous tissue. After maceration, the crystalline lens breaks into triangular pieces composed of concentric scales, of which the apices meet in the centre. The anterior may sometimes be separated from the posterior part of the lens, at the line of its circumference, as if it were composed of two segments of spheres of unequal size, applied face to face. The crystalline lens discovers no vascular organization.

PHYSIOLOGY

OF

THE EYE,

AND ITS APPENDAGES.

THOUGH an examination of the phenomena of vision and the laws which regulate it, may be considered by many as a subject more allied to philosophy than medicine, yet as the description of the structure of an organ would necessarily be incomplete, without at the same time giving an account of its functions, so on that account, would the preceding description of the structure of the apparatus of vision, be incomplete, were I to omit a description of the *physiology of vision;* and the history of its diseases would want the illustration which a competent knowledge of its economy conveys.

In entering into the investigation of the functions of an organ, which is acknowledged by all to be *the most perfect* of optical instruments, it is clearly necessary to bring to the investigation a considerable share of knowledge, concerning the laws of optics, and although, the greater number will doubtless be in possession of that information beforehand, it may not be out of place to point out briefly the general laws of optics, and more especially those which bear directly on the subject under consideration.

IMPRESSIONS OF LIGHT ON THE RETINA ARE MECHANICAL.

The expansion of the optic nerve, or the retina, which is disposed as a cup at the posterior part of the eyeball,

has the wonderful property of communicating to us sensations of colour, when adequate impressions are made upon it. A blow upon the eye causes it to appear to flash fire; and pressure on the side of the eyeball excites a sensation of coloured circles. The impressions by which we see, although of an incomparably more delicate nature than the preceding, yet, like them, are mechanical impulses upon the retina. They are produced by LIGHT.

NATURE OF LIGHT.

Light consists either of imponderable and infinitely minute material particles emitted from luminous bodies, or of undulations of an ethereal medium supposed to pervade all space. A succession of particles on the one theory, or of undulations on the other, constitutes a ray of light. Rays of light move only in straight lines: their velocity is so great, that they travel from the sun to the earth, a distance of 95,000,000 miles in 8½ minutes. Light, therefore, is an intermediate agent through which bodies make a mechanical impression on the retina.

Light emanating from luminous bodies forms diverging cones, which, if they met with no obstruction, would be prolonged indefinitely. Hence it has been concluded, that the intensity of light in any place, is in the inverse ratio of the square of the distance of the luminous body from which it emanates.

DIVISION OF BODIES INTO LUMINOUS, OPAQUE, AND TRANSPARENT.

According to the different properties which bodies exhibit in regard to light, they have been classified into

luminous, opaque, and transparent. A *luminous* body is one that shines by its own light, as the sun, the fire, a candle, and so forth. But all bodies that shine are not luminous; polished metal, for instance, is not a luminous body, for it would be dark if it did not receive light from a luminous body: it belongs therefore to the class of *opaque or dark bodies*, which comprehend all such as are neither luminous nor will admit the light to pass through them. And *transparent bodies*, are those which admit the light to pass through them; such as glass and water.

No material bodies appear to be perfectly opaque or transparent. Leaf gold sensibly transmits a greenish light, and on the other hand, a depth of seven feet of water intercepts one half of the light which passes through it.

Light moves in right lines; but its path is liable to be altered in two different ways, depending on the class of bodies it has to encounter in its progress.

CATOPTRICS, AND DIOPTRICS.

If the rays of light, in their progress, encounter opaque bodies, they are reflected. The study of this branch of optical science is called *Catoptrics*. If, on the contrary, the rays of light impinge on transparent bodies, they are allowed to pass through them, not however in a right line, but at an angle which varies with the density of the body: in this case the rays of light are said to be *refracted;* and the study of this branch of the subject is called *Dioptrics*.

LAWS OF REFLECTION.

All visible bodies that are not luminous, are seen by

means of rays thrown back or reflected from their surface. Light in its reflection is governed by the same laws as solid, perfectly elastic bodies. If a ray of light fall upon an opaque body perpendicularly, it is reflected perpendicularly. If a ray of light fall upon a surface obliquely, it is reflected obliquely, but in the opposite direction, the angle of incidence being equal to the angle of reflection. The term reflection is usually confined to those cases in which the rays are thrown back in a definite order, either in lines parallel to each other, or uniformly convergent or divergent. To produce this species of reflection, a surface must be highly polished, in order that there may be uniformity in the angles at which the greater part of the rays are returned.

REFRACTION.

Refraction is the effect which transparent media produce on light in its passage through them. If a ray of light, in passing from one medium to another of different density, falls vertically on its surface, no refraction takes place, and it continues its course through the medium in its original direction. If the ray enter the new medium obliquely, it deviates from its course, and appears broken at the point of immersion, or that point of the surface at which the ray enters. If the ray of light passes from a rarer to a denser medium, it approaches the perpendicular at the point of contact; it separates from it, on the contrary, when it passes from a denser to a rarer medium. The same phenomenon occurs, but in an opposite manner, when the ray again enters the first medium; so that if the *two surfaces* of the *medium* which the ray traverses

are *parallel*, the ray, on returning into the surrounding medium, will take a direction *parallel* to the incident ray.

The *angle* of *incidence* is that which is made by the incident ray with a perpendicular line drawn through the point of immersion on the surface of the medium, and the *angle of refraction* is that which is made by the broken ray with the same perpendicular.

ANGLE OF REFRACTION DEPENDING ON DENSITY.

The extent of refraction produced by the same medium depends upon the angle at which the rays of light enter. Bodies refract light in proportion to their density and combustibility. Thus, if two bodies are of equal density, but the one is composed of more combustible elements than the other, the refracting power of the first will be greater than that of the second.

DIAPHANOUS BODIES.

All *diaphanous* bodies, when they refract light, also reflect it. In consequence of this property, those bodies, to a certain extent, fulfil the office of mirrors. If they have little density, as the air, they are not visible unless the mass is considerable.

DIRECTION OF THE REFRACTED RAYS AFFECTED BY THE FORM OF THE BODY.

The form of the refracting body does not influence the refracting power, but modifies the disposition of the refracted rays with respect to each other. In fact, as perpendiculars to the surface of a body approach and recede according to its form, so do the refracted rays approach and recede from each other.

According to the form of the refracting bodies, the rays of light have either a tendency to *converge* to a *point* or *focus*, or to *diverge*, or to proceed onwards in parallel lines. If the two surfaces of a body be *parallel*, the refracted rays are *parallel*. If either or both surfaces are *convex*, the refracted rays will *converge* to a central point. On the contrary, if the surfaces be *concave*, the refracted ray will, to an equal extent, *diverge* from the central point.

VARIOUS FORMS OF REFRACTING MEDIA.

The substance which is most commonly employed for refracting the rays of light, both in optical experiments, and in optical instruments, is glass: which, for these purposes is shaped into a variety of forms. 1st. A *plane glass*, in which the two surfaces are parallel. 2d. A *spherical lens*, which has every point of its surface equally distant from a common centre. 3d. A *double convex lens*, which is bounded by two *convex* spherical surfaces, whose centres are on opposite sides of the lens: it is either *equally* convex, when the radii of both surfaces are equal; or *unequally* convex when the radii are unequal. 4th. A *plano-convex lens*, which is bounded by a plane surface on one side, and a convex on the other. 5th. A *double concave lens*, which is bounded by two *concave* spherical surfaces, whose centres are on opposite sides of the lens. 6th. A *plano-concave lens*, which is bounded by a plane surface on one side, and a concave one on the other. 7th. A *meniscus*, which is bounded on one side by a concave surface, and on the other by a convex one; and these two surfaces meet at the circumference if continued. 8th. A

concavo-convex lens, bounded by a concave and convex surface; but these two do not meet at the circumference, though continued. 9th. A *prism*, having two plane surfaces inclined to one another. The first of these transmit the rays in a parallel direction. The 2d, 3d, 4th, 7th and 8th, all cause the rays of light to converge towards a central point or focus. The 5th, 6th, and 9th, produce a divergence of the rays of light.

REFRACTION MODIFIED BY THE RELATION OF THE SURFACES.

The rays of light, when transmitted through a medium having both surfaces *parallel*, undergo two refractions, one at the point of *immersion*, and the other at the point of emergence, and these being equal and in *opposite* directions, no sensible effect is produced, and the rays continue onward in *parallel lines:* if, however, the two surfaces of the refracting medium be not parallel, then the rays of light, in passing through it, will in like manner undergo two refractions, but these will take place in the *same* direction, and therefore the rays of light, after being refracted, *will not be parallel;* if the surfaces be *convex*, those rays which fall obliquely upon it will be refracted *towards* the axis, and will meet at a point beyond the lens called its *focus*, a point which depends both upon the form of the lens, and the refractive power of the substance of which it is made; if, however, the surfaces be concave, or oblique as in the prism, then those rays which fall obliquely upon it will be *refracted* from the axis, and consequently will be *dispersed*.

COMPOUND NATURE OF LIGHT.

If we examine the rays of light, after they have undergone refraction by means of a prism, we become aware of the curious and important fact that ordinary white light is itself composed of a multitude of rays of different colours and different degrees of *refrangibility*. If a bundle of rays is made to pass through a glass prism or any other refracting body, whose surfaces are not parallel, the bundle enlarges, and if, after its departure from the body, it is received upon a plane, as a sheet of paper, it is found to occupy a large extent, and instead of producing a white image, it produces an oblong one of many colours, succeeding each other by insensible degrees, and among which the seven following are distinguishable; red, orange, yellow, green, blue, indigo, and violet. Each of these colours is indecomposable; their assemblage forms the solar spectrum. The primitive colours are stated by some to be only three, red, yellow, and blue: and that the intermediate tints of orange, green, indigo, and violet, are only combinations of the other three; this, however, is matter for dispute. Light, therefore, is not simple and homogeneous, but is made up of innumerable coloured rays, which by their union constitute white light. The compound nature of light is proved, as I have already stated, by the action of the prism, by means of which the different coloured rays, of which white light is composed, are separated according to the angles at which they are refracted. The violet rays have the greatest angle of refraction, consequently they deviate most from their original course, and appear at one extremity of the *spectrum*.

Contiguous to the *violet* are the indigo, then follow in succession, the *blue*, *green*, *yellow*, orange, and lastly red, which, as they have the smallest angle of refraction, deviate least from their original course, and consequently appear at the other extremity of the *spectrum*. The compound nature of light may be further proved by the fact, that by the recombination of these coloured rays, white light is again produced. This can be done by letting the coloured rays, which have been separated by a prism, fall upon a lens, which will make them converge to a focus; and, when thus reunited, they will appear white as they did before refraction: or, if a card be painted in compartments with these seven colours, and made to revolve rapidly, the same effect will be produced, white light being the result.

THE CAUSE OF COLOUR.

Upon our knowledge of the compound nature of light depends the explanation of the colour of bodies. Colour does not absolutely reside in the body itself, but is dependent on the power which material bodies possess, of absorbing some rays, and reflecting others. A body, which, when viewed by white light appears red, will, when viewed by any of the prismatic colours, appear of that colour, whichever it may be. The reason is plain; in the first example the white light suffered decomposition, the red rays alone were reflected, all the rest were absorbed; in the second example, the coloured rays admitted of no further decomposition, and consequently were reflected unchanged. A body appears therefore to be of the colour which it reflects; as we see it only by

reflected rays, it can only appear of the colour of those rays. Objects in the dark have no colour, or are black, which is the same thing. Light is composed of colours, therefore there can be no colours without light; and though every object is black, or without colour in the dark, it becomes coloured as soon as it becomes visible. Though bodies from the arrangement of their particles, have a tendency to absorb some rays and reflect others, yet they are not so perfectly uniform in their arrangement as to reflect only pure rays of one colour, and perfectly absorb the others. A body reflects, in great abundance, the rays which determine its colour, and the others in a greater or less degree, in proportion as they are nearer or farther from its own colour in the order of refrangibility. Bodies which reflect all the rays are white; those which absorb them all are black. Between these extremes, they appear lighter or darker, in proportion to the quantity of rays they reflect or absorb. Pale coloured bodies reflect all the coloured rays to a certain extent, which produces their paleness, approaching to whiteness; but one colour they reflect more than the rest: this predominates over the white, and determines the colour of the body. Since, then, bodies of a pale colour in some degree reflect all the rays of light, in passing through the various colours of the spectrum, they will reflect them all with tolerable brilliancy, but will appear most vivid in the ray of their natural colour. Transparent bodies also appear coloured by the light which they refract, and when seen by refraction, they often appear of a different colour, than when seen by reflection.

If it is inquired why such a body reflects a certain

colour, while another absorbs it? It may be answered, that this tendency, to absorb or reflect particular rays, is *supposed* to depend on the arrangement of the minute particles of the body, and that the diversity of arrangement renders some bodies susceptible of reflecting one coloured ray, and absorbing the rest, whilst others have a tendency to reflect all the colours, and others again to absorb them all. How far this may be considered in the light of an explanation, each must determine for himself.

In the preceding sketch, it has been attempted to explain, as clearly as our limits would permit, some of those general laws which regulate the reflection and refraction of light. We are now better qualified to enter into an examination of the physiology of vision, and to examine in what manner, the various portions of the apparatus of vision contribute to the performance of perfect vision.

APPARATUS OF VISION.

The apparatus of vision is composed of three parts.

The first modifies light.

The second receives its impression.

The third transmits this impression to the brain.

The texture of the apparatus of vision is so extremely delicate, that it is affected by the slightest cause; nature, therefore, has placed before it a series of organs to protect and preserve it in the conditions requisite for the exercise of its functions.

These protecting parts are the eyebrows, eyelids, and secretory and excretory organs of the tears.

EYEBROWS.

The *eyebrows* have many uses. The projection which they form protects the eye from external violence; the hairs, from their oblique direction, and the oily matter which covers them, prevent the perspired fluid from running towards the eye and irritating the surface of this organ, and direct it towards the temple and root of the nose. The colour and number of the hairs of the eyebrows influence their use. They usually vary with climate. In the natives of hot climates, they are very thick and black; in those of cold climates, they may be thick, but are very rarely black. The eyebrows protect the eye from the impression of too strong a light, more especially when coming from above: we increase this effect by frowning.

EYELIDS.

The *eyelids* cover the eye during sleep, and preserve it from the contact of foreign bodies flying in the atmosphere; guard it from blows by shutting almost instantaneously; by their habitual motions, which occur after nearly equal intervals, they oppose the effects of the prolonged contact of the air; they also moderate the force of too strong a light, for, by approximating, they allow such a quantity of it to pass as is necessary to vision, but incapable of injuring the eye. On the contrary, when the light is weak, we open the eyelids widely, to allow as much as possible to enter the eye.

EYELASHES.

When the eyelids are brought near each other, the *eye-*

lashes form a sort of grating, which permits a certain quantity only of light to pass at once. When the eyelashes are wet, the little drops on their surface decompose light as the prism does, and the point from which it emanates appears irradiated. The eyelashes, by separating into bundles the light which penetrates the eye, cause bodies on fire, during the night, to appear surrounded with luminous rays. This effect disappears the moment the lids are opened, or merely another direction given to the eyelashes. We may readily conceive that the eyelashes protect the eye from the particles of dust which fly in the air. Vision is always more or less altered in persons deprived of their eyelashes.

EYELIDS PERMEABLE TO LIGHT.

The closed eyelids are penetrated by a full light, so as in ordinary circumstances to occasion waking; and distress to persons whose eyes are inflamed. The superior tarsus, when drawn up, slides under the arch of the orbit, but retains its apposition to the globe, owing to the laxity of its attachment with the integument of the palpebra.

MUSCLES OF THE EYELIDS.

The levator palpebræ being purely a voluntary muscle, the simple suspension of its action effects the closure of the eyelids, as its contraction opens them in the act of waking. Hence, the disposition in the upper eyelid to fall, announces the approach of sleep. In febrile and exhausted states of the system, its impaired energy occasions the drooping expressed by the term "heavy eyed," one of the most characteristic symptoms in the physiog-

nomy of disease. A similar state belongs to some morbid affections of vision, of which I shall have occasion to speak hereafter. A voluntary closure of the eyelids, as when the eye is, from any cause, irritable to light, is performed by the orbicularis palpebrarum, which in some casualties and morbid states, contracts spasmodically, and the relaxation of this muscle assists the opening of the closed eyelids. In going to sleep and awaking from it, the lower lid is therefore passive ; in a voluntary shutting and opening of the eye it participates, although inconsiderably, in both actions. Winking is an alternation of the actions of the levator and orbicularis, and therefore a seasonable relief to the former, and a means of preserving the moist and clear condition of the cornea. It is performed by a very slight contraction of the palpebral portion of the orbicularis. The combination of the action of the corrugator and orbicularis is seen in the strained closure of the lids to resist their separation by external force, knitting and depressing the eyebrows and throwing the nose and forehead into folds ; and the equipoise of the actions of the orbicularis and levator is evinced in the approximation or screwing of the eyelids, and peering, as is customary in short sighted persons. When they are both in full action, the corrugator acts as a moderator to the levator ; the orbicularis is the antagonist of the latter.

CONJUNCTIVA.

The *conjunctiva* protects the anterior surface of the eye, secretes a fluid which mixes with the tears, and appears to

have the same office; possesses the power of absorption, supports the friction which occurs when the eye moves, and, being very highly polished and constantly moist, render these motions very easy. Lastly, it receives the contact of the air when not covered by tears. According to Mr. Travers, the idea that the conjunctiva is a secreting membrane, "rests solely on the supposed relation of the conjunctiva to the class of mucous membranes." But this need be no fetter upon our conception of the matter; for not only do we see from the varieties of its surface, that its economy is not throughout the same, but anatomists describe its continuity with the cutis as much as with the membrana narium. Again, the capillaries of mucous membranes carry red blood, which is not the case in the conjunctiva of the globe in health. But there is no evidence of such a secretion; upon the cornea it is not assumed to exist, yet the difference between the corneal and sclerotic portions is only in the strictness of its adhesion. The follicles and caruncula are specifically provided for preventing the effects of friction, and the incessant, although insensible escape of the tears from the lachrymal ducts, unavoidable under the act of winking, in which the upper lid sweeps over and preserves the polish of the cornea, renders such a provision superfluous, and therefore improbable. In disease the sclerotic conjunctiva secretes a mucus which is immediately obvious (the corneal surface is excepted) because its vessels do not admit red blood, and this is in conformity with what we see of the mucous membrane properly so called, as of the urethra and intestinal canal, which continually shew that

the secretion can be set up by disease upon a whole surface, while in the healthy state this function is confined to its follicles and lacunæ.

A young woman who had never shed tears, and was incapable of doing so, had a shrivelled, opaque, and cuticular conjunctiva.

SECRETION AND USE OF THE TEARS.

The *lachrymal gland* secretes the *tears*, and by means of several small ducts, pours them upon the conjunctiva at the upper and back part of the eye. But what becomes of them when arrived at this part? This we shall now explain. We observe, in the first place, that they must flow in a different manner when we are asleep than when we are awake. When we are awake, the eyelids are alternately approaching and separating from each other; the conjunctiva is exposed to the contact of the air; the eye is in continual motion; nothing of this kind occurs during sleep.

Physiologists suppose that the tears flow in a triangular canal, destined to conduct them towards the great angle of the eye, where they are absorbed by the puncta lachrymalia. This canal, they say, is formed, 1st, by the edge of the eyelids, whose surfaces, rounded and convex, touch only at one point; 2dly, by the anterior surface of the eye, which completes it behind. The external extremity of this canal is more elevated than the internal. This disposition, joined with the contraction of the orbicularis muscle, whose point is fixed to the nasal process of the superior maxillary bone, directs the tears towards the puncta lachrymalia.

This explanation, according to M. Majendie, is defective: the eyelids are in contact, not by a rounded edge but by their margins, which are flat; the canal, therefore, of which they talk does not exist. In fact, if we examine the posterior surface of the eyelids when in contact, we can scarcely detect the line which indicates the point at which they touch. Besides, if we admit the existence of this canal, it can only serve for the passage of the tears during sleep; we should still have to enquire into their course during the waking state.

During Sleep.

During sleep, and whenever the eyelids meet, the tears gradually diffuse themselves over all the ocular and palpebral surface of the conjunctiva, and must stream in the largest quantity where they find the least resistance. The course which presents the fewest obstacles, is along the part where the conjunctiva passes from the eye to the lids; along this they easily arrive at the puncta lachrymalia. The tears thus diffused upon the conjunctiva must mix with the fluids secreted by this membrane, and experience the absorption, which it carries on.

When awake.

When we are awake, things go on differently. The portion of the conjunctiva in contact with the air, allows the tears which are upon it to evaporate, and would become dry if the tears were not renewed by the motion of winking, of which I conceive this to be the chief purpose. The tears thus lying on the part of the conjunctiva exposed to the air, form an uniform layer upon it, which

gives to the eye its polish and brilliancy; the increased or diminished thickness of this layer greatly influences the expression of the eyes; in empassioned looks, for instance, it is obviously thicker.

In the ordinary condition of the lachrymal secretion, the tears are not in the least disposed to overflow the lower eyelid. I know not upon what can be founded the use commonly ascribed to the fluid of Meibomius, of opposing this overflow, somewhat as a layer of oil upon the edge of a watery vessel opposes a watery fluid which rises above it. This effect of the Meibomian secretion I doubt, because it is soluble in the tears. The tears which do not evaporate, or are not absorbed by the conjunctiva, are absorbed by the lachrymal ducts, and carried to the inferior meatus of the nostrils by the nasal canal.

Muscular compression of the Lachrymal Sac.

The origin of some fibres of the orbicularis from the ligamentous expansion which supports and protects the lachrymal sac, gives it a power of compressing the sac in its contraction, and thus assists in the excretion of tears. This is in part proved by the epiphora which accompanies a fixed state of the lower palpebra from injuries, and the paralysis of the orbicularis, which states also prevent the due opposition of the puncta. Hence, too, people wink often and forcibly whose eyes are disposed to water, and after shedding tears.

EXCRETION OF TEARS.

The puncta lachrymalia absorb the tears, not by any capillary attraction, but by a vital action as absorbent

mouths. They are often spasmodically contracted, and afford a resistance to the introduction of Anel's probe, but yield to the point of a pin, so as afterwards readily to admit a probe of much larger dimensions. When over dilated, they lose for a time their absorbing power, and the epiphora is increased. When they are morbidly patulous and atonic, as sometimes happens in age, the epiphora is permanent; and their function is frequently arrested by inflammation of the sac, for we often find the epiphora altogether independent of obstruction. The direction of the superior duct varies a little in relation to the sac, according to the degree of elevation of the upper lid. By drawing the lid upwards and towards the nose, it is brought nearly into a line with the axis of the sac. The area of the sac and nasal portion of the duct, exceeding that of their orifices, facilitates the passage of the tears; the slight elevations of the lining membrane, and the narrowness and obliquity of the nasal opening, probably retard the excretion, which would be inconvenient if constantly taking place.

ACTION OF THE MUSCLES OF THE GLOBE OF THE EYE.

The actions of the *recti* singly, are to direct the eye to four equidistant points of a circle, and, in concert, to turn the eye towards all the intermediate points: they also exert a constant effort to retract the eye, against which the elasticity of the optic nerve, and of the adipose tissue in the orbit, would make a very inadequate resistance.

The action of the *obliquc muscles* is involved in some obscurity: there can indeed be no doubt respecting their principal use; by drawing the eye forwards they prevent

that constant retraction which would otherwise be produced by the recti. But individually they are calculated to give, each its specific direction to the eye: the *obliquus superior* points the optic axis downwards and inwards; the *obliquus inferior*, on the other hand, directs the eye upwards and outwards. The combined actions of the whole preserve the relative position of the eye to the object, independent equally of the motions of the object and the head. The motions of the eyes are in perfect accordance, and the will cannot place them in opposition.

What renders this question still more intricate, is that three nerves are employed to supply the six muscles that have been described. The fourth nerve supplies the obliquus superior, the sixth supplies the rectus externus, and the third supplies the remaining muscles.

It is remarkable again, that of the six muscles of the eyeball, three turn the optic axis directly or obliquely outwards, (provided the obliquus superior is a rotator outwards, as many suppose,) and that each of these three muscles is supplied by a different nerve; two indeed have an entire nerve exclusively distributed to each of them.

The intricacy of the muscular motions of the eye admits, however, of a conjectural explanation. We may remark, that their distribution is not such as to allow of our opposing the recti to the obliqui: in following this indication we are stopped by the fact, that the third nerve supplies half or greater part of each class. But from the close anatomical relation between the origins of the third nerve and of the fourth, we may conclude *their* function to be not materially different; whereas the sixth nerve, rising from a remote point, seems distinguished from both the others.

It appears to be a principle universally observed in the construction of the nervous system, that nerves of motion rise near the origin of those sentient nerves, through which the actions they control are habitually guided or called into play.

This principle is remarkably shown in all the spinal nerves, and in the distribution of the fifth and seventh cerebral nerves; and the origin of the third and fourth nerves is perhaps sufficiently near that of the optic nerve to bring them both under the same law. Now, when we investigate the origin of the sixth nerve, we find it passing to the back part of the medulla oblongata, so as to rise near the fifth and seventh; in other words, it rises near those nerves which comprehend within their functions, the sensibility of the surface of the eye, an influence over the secretion of the lachrymal gland, and the sense of hearing. Again, when we examine the distribution of the sixth nerve we find it forming the sole supply of a muscle which has a remarkable consent with the three offices alluded to. The rectus externus or abcens oculi, which it supplies, directs the axis of the eye outwards. And we may remark, 1st, that when the optic axis is directed outwards, the surface of the eye is carried towards the orifices of the ducts of the lachrymal gland; 2dly, that the reversion of the eye for vision is commonly suggested by impressions upon the organ of hearing; and, 3dly, as an instance of the consent between the common feeling of the eye and the action of the abductor, that, when an animal is destroyed by pithing, if while imperfect life yet remains in the head, the eyelids be rendered incapable of closing by the division of the portio dura,

and the surface of the eye be then touched, the motion of the eye to avoid the offending substance is in a direction outwards.

When the eyelids are kept shut, the eyes are often in motion. "Inter somnum quietum atque placidum, (observes Soemmering in his Icones Oculi Hannani,) bulbus oculi, ut in ipsis somnolentis videre licet, paulo plus sursum trahitur." In some instances this elevation of the axis of the eye during sleep is very considerable, in others it is very slight.

SQUINTING, ITS NATURE AND CAUSES.

Squinting consists in a want of consent between the muscles of the two eyes, through which defect the optic axes are habitually directed towards different points. The inclination of one eye inwards may be so great as to exclude it from the vision of objects towards which the other is turned, or may be so slight as to allow of the distorted eye taking in part of the same field of vision with its fellow. In either case, it appears that those who squint habitually neglect the impressions upon the distorted eye, and see with but one eye.

The *cause* of squinting is obscure: for though it frequently happens that the eye, which squints, has an imperfect vision, so as to favour the supposition that it is instinctively averted in order to prevent the perception of objects becoming confused; yet, in other cases, vision with either eye is equally good, and the patient can at will employ either singly, but cannot prevent the other from turning away from the object of vision.

Perhaps in cases of the latter description the original adjustment of the two eyes is not true; so that if both were directed towards the same object, it might necessarily appear double.

THE REFRACTING MEDIA OF THE EYE.

The eye consists of various parts, some of which refract the rays of light in their course, whilst others receive and transmit the impression produced by them. The refracting parts are,—

A. The *transparent cornea*, a refracting body, convex and concave, resembling very much in its figure, transparency, and mode of insertion, the glass placed before the face of a watch.

B. The *aqueous humour*, filling the chambers of the eye; it is not purely aqueous, as its name implies, but is composed of water and a little albumen.

C. The *crystalline humour*, improperly compared to a lens. The comparison is exact as far as regards form; but with respect to its structure is completely defective; for the crystalline humour consists of concentric layers, gradually increasing in hardness from the surface to the centre, and probably of different refractive powers. The crystalline is besides enveloped in a membrane, which experience proves to be of great importance in vision. A *lens*, on the contrary, is homogeneous throughout, at its surface, and every point of its substance, and has also throughout the same power of refraction.

D. Behind the crystalline is the *vitreous humour*, so called from its resemblance to melted glass.

The humours of the eye, according to Berzelius, consist of,—

	Aqueous humour.	*Vitreous humour.*
Water	98.10	98.40
Albumen	a trace.	0.16
Muriates and lactates	1.15	1.42
Soda, with animal matter soluble in water	0.75	0.02
	100.00	100.00

Crystalline Lens.

Water	58.
Peculiar matter, analogous to the colouring matter of the blood	35.9
Muriates, lactates, and animal matter soluble in alcohol	2.4
Animal matter soluble only in water	1.3
Insoluble membrane	2.4
	110.0

The refracting powers of the humours of the eye are, according to different observers, as follows :—

	Aqueous humour.	*Vitreous humour.*	*Crystalline Lens.*		
			Outer coat.	Centre.	Mean.
Hawksbee,	1.335	1.335			
Jurin,	1.333				
Rochon,	1.329	1.332			
Young,	1.333				
Brewster,	1.336	1.339	1.376	1.399	1.383

From the last of these measures we may deduce the following indices of refraction :—

	Index of refraction.
For rays passing from the aqueous humour into the outer coat of the crystalline humour . .	1.046
For rays passing from the aqueous humour into the crystalline, taking its mean index of refraction	1.035
For rays passing from the outer coat of the crystalline into the vitreous humour . . .	0.93

Besides these refracting media, there are various other parts, each of which has some particular use in vision.

A. The *sclerotic* membrane, the external coat of the eye, fibrous, thick and resisting, and evidently intended to protect the interior of the eye; it serves also for the insertion of the muscles which move the eye.

B. The *choroid* membrane, a vascular and nervous membrane covered with a black matter, which is of much importance in vision, by absorbing the superfluous light.

C. The *iris*, found behind the transparent cornea, of different colours in different persons, and pierced in the centre by an opening called *pupil*, which increases and diminishes according to the intensity of the light.

D. The *retina*, or membranous expansion of the optic nerve, which is specially destined for the reception of impressions made by the rays of light.

E. The *optic nerve*, through the medium of which we become conscious of impressions made upon the retina.

THE MECHANISM OF VISION.

The rays of light in passing through the various humours of the eye undergo a series of refractions, by which

they are collected into focal points upon the retina, so as to form a complete picture of the external scene.

INVERSION OF THE IMAGE.

From what has been already said, it will be perceived that each pencil will consist of a double cone of rays, the axes of which are right lines, their bases meeting in the crystalline, and their apices being situated in the object and the retina respectively. The rays from the top of the object are deflected to the bottom of the eye, and those from the side of the object to the right of the observer, are deflected to the left side of the eye, and vice versa; hence the inversion of the picture upon the retina. The following simple experiment, demonstrating this fact, is well known. A portion of the coats being removed from the back of the eye, and their place supplied by a piece of oiled or tracing paper, the flame of a candle placed before the cornea is exhibited of diminished size, and inverted. We infer, that this image excites the perception of the object, because distinct vision is enjoyed only in such conformations and conditions of the eye, as to allow its being accurately formed and impressed.

If we look in a concave mirror, objects appear inverted. The image formed upon the retina is in this case erect, and we see the object in the same relative position to the image as all other objects. Of this fact any one may convince himself, by preparing an eye, as before mentioned, and placing beside and a little behind the flame of the candle a spoon, the hollow of which reflects it inverted, when he will observe on the opposite side of the

oiled paper, the images of the real and the reflected object, the first inverted, the second erect.

Common theories.—It has been generally supposed that we actually see objects inverted, and that this error of the sight is corrected by experience. Some, on the contrary, have supposed that the mind acquires the perception of objects, not from the picture upon the retina, but from the object itself, by retracing the direction of the pencils to their points of radiation. Others assert, that a decussation of the fibres of the optic nerve corrects the erroneous impression before it is presented to the sensorium.

Berkeley's theory. — The celebrated explanation of Berkeley, in so far as it admits of an abridged exposition, is as follows. Visible and tangible ideas occupy distinct provinces, and have originally no affinity to each other. It is only by experience that they become connected. The impressions on the organ of sight suggests by association the ideas of objects acquired by the sense of touch, just in the same way as the word used to denote an object immediately suggests the idea of that object, to a person who is familiar with the language. *The image on the retina is merely the instrument, not the object of vision.* Its position has originally no influence on the ideas we form of the situation of external objects; and the supposed difficulty in the case of the inverted images arises from confounding ideas derived from the sense of touch with those derived from the sense of sight.

The association of ideas derived as they are from the external senses, operates imperceptibly to an extent that we have no means of ascertaining, because the original

and absolute negation of each sense in succession, so that each should be in turn insulated, is an impossible condition, notwithstanding the seemingly possible independence, in a state of society at least, of the animal and vital functions. Touch, in the extended sense of physical feeling, is the basis of all; sight, hearing, smell, and taste, like the sense of touch itself in its strict and limited import, are but modifications of it. That either or all of these, therefore, should be wanting, is not incompatible with their constitution; but the sense of contact is so essentially and individually incorporate with the organic nervous system, that its negation would be paramount to *acephalous monstrosity*. Hence its influence as a substitute and corrector in relation to the rest, when wanting can never be fully appreciated, because it cannot, like them, be subjected to analytical test. But from what we see of the effects of privation of one or more of the external senses, and of their reciprocity in general towards each other in cases of malformation and disease, is it not in the highest degree probable, that their natural intercourse and cooperation are essential to the development of each respectively? To illustrate this position. If it be possible to suppose a case in which the eye was the only external organ of sense, would the unfortunate possessor have any distinct idea of visible objects; or, mutatis mutandis, the ear of sounds? Certainly not. Dumbness is in most cases only a consequence of the absence of hearing; the organs of speech are perfect: so the loss of visual perception (not of light more than of unharmonized articulation) would result in the case sup-

posed, from the absence of the associated sensations and ideas thence derived.

Explained by the law of visual direction.—After all that has been said about the *inversion of the image*, and the perplexity which theorists have involved it in, by attempting to explain it; it will be found, if we admit the law of *visual direction*, to be not only easy of explanation, but to be, in fact, the only means by which correct vision could have been obtained. It has been stated to be the particular endowment of the retina, that when adequate impressions are made upon it, sensations of colour are produced. A very trifling addition to this statement contains the enunciation of a principle, upon which almost all the phenomena of vision depend, and to which the entire construction of the eye has reference. *When an impression is made upon the retina sufficient to produce sensations of colour, the colour appears projected in a line vertical to the point of the retina which has been excited.* Thus, if pressure be made with the finger upon the outside of the eyeball, a circular spectrum is seen in the direction of the nose; if the pressure be made at the upper part of the eyeball, the spectrum appears towards the cheek; if below, towards the eyebrow. The spectrum is always opposite to the point compressed, or is projected in a line vertical to the point of the retina which is excited to sensation. It appears that, by this endowment of the retina, the *direction* is rigorously determined, in which we can see by each point of its surface. The upper part, when excited, sees downwards, the lower part upwards, the inner outwards, the outer in-

wards. Through this law of *visual direction*, the inverted image on the retina is seen in the opposite or correct position.

Now the retina is to be used in giving us notions of the visual directions of objects, which are to correspond exactly with the notions that we derive from the sense of touch. Accordingly, we find placed before the retina a series of media, the effect of which is to produce true vision by means of the law of visual direction above mentioned: these are the *refracting media*, which have been already mentioned.

ABERRATION OF LIGHT FROM UNEQUAL REFRACTION.

In speaking of the refraction of rays at the surfaces of spheres and lenses, we have supposed that all the rays meet exactly in the focus. This, however, is not strictly the case; for if rays, falling on the surface of a sphere at a particular point, are collected to a focal point beyond this lens, other rays falling on the surface of the lens nearer to the axis, will have their focus at a point farther from the sphere than the former. This is easily proved by actually projecting the refracted rays, and if it is done for those rays farthest from the axis, and for those nearest to the axis, the difference between the foci of these rays is called the *spherical aberration*, or the *aberration* or *straying* of the rays from the focus, caused by the *spherical* figure of the lens. This aberration arises from the curvature of the lens being equally spherical, for if the surface of the lens was more convex towards the

axis, the focal distance of rays falling on that part would be diminished, and consequently would be less.

Hence, in order to refract rays at different distances from the axis to the same point, the surfaces of the lens must have different degrees of curvature at different distances from the axis. The lens with least spherical aberration is a double convex one, whose radii are as one to six; the side whose radius is one being turned towards parallel rays. The aberration then is $\frac{7}{100}$ths of its thickness. As it is desirable to reduce this aberration in all optical experiments, but more especially in vision, to the lowest possible degree, various contrivances have been adopted to accomplish this end. In optical instruments this is effected by the combination of lenses of various forms, by which means their aberration is *neutralized.* In the eye this is compensated by a variety of means, which we shall now take notice of.

CORRECTION OF ABERRATION FROM UNEQUAL REFRACTION.

The necessary effect of the spherical figure of the cornea is to occasion an unequal refraction of the rays which permeate it, and hence to create a degree of aberration which would confuse vision. This is corrected in two ways: first, by the mobility of the iris, which, adapting the size of the pupil to the circumstances of the case, excludes, more or less, those rays which would produce aberration; and secondly, by the gradually increasing density of the lens from the circumference to the centre, and its consequently refracting with less power the rays which arrive at it with a considerable obliquity.

OFFICE OF THE IRIS.

It has been stated that the iris serves to arrest those rays which are denied admission through the pupil: they would be unequally refracted by those points of the lens through which, if uninterrupted, they must pass, or would fall so obliquely on the cornea, as to be subjected to too great a refraction. This is its passive function; but by its power of dilatation and contraction, in obedience to the stimulus of light upon the retina, it determines the quantity necessary for the purposes of distinct vision. In regulating the quantity of light, the iris materially assists in accommodating the eye to different distances; in viewing a distant object the pupil dilates, and in viewing a near one it contracts. It is true that viewing the sun occasions a contraction of the pupil, and the stedfast vision of a near object in deficient light, its dilatation. These are confirmations of the statement that its motions are in obedience to the impression of light upon the retina, because the direct emanation of light from its source in the one case, and the insufficient light in the other, render these objects analogous in this respect to the nearest and the remotest visible objects. But under ordinary circumstances, the illumination of objects being conformable to the distance, the pupil, in viewing a distant object, is dilated so as to admit as many rays of the enfeebled light as is necessary to the distinct perception of the object; and on the other hand contracts, to exclude the superfluous rays, which, coming from a near object, would otherwise create confusion. Let a person survey the sun whilst the pupil is fully dilated by bella-

donna, or under the same circumstances, the flame of a candle, brought near to the eye, and in either case he will find his vision confused to dimness. But the fullest dilatation of the pupil will not injure the clearness of his vision of any other remote object; though the vision of all near objects will be in a degree confused, and the confusion be increased in proportion to the degree of their illumination. Where the iris is from any cause motionless, the power of adapting the eye to distances is lost. I conclude, therefore, that the adaptation of the eye to light cooperates with its adaptation to distance.

Iris in part muscular.—Notwithstanding the absence of satisfactory anatomical proof, I cannot but regard the motions of the iris as muscular motions, and the pupillary portion an orbicular sphincter, such as environs the several outlets or apertures of the body. To this structure I attribute its uniformity under varying magnitudes; its incapacity of contraction, when having a fixed point, as happens in some malformations; when confined by adhesion at any point of the circle to the capsule of the lens, or when its texture has been the subject of adhesive inflammation; its recovery of a prolapse through a section of the cornea, and resuming its circular figure when over-stretched, as in extraction, by a gentle friction of the eyelid—the extreme velocity of its contraction, and the comparative slowness of its relaxation—its ordinary preservation of a mean or middle state, between the spasmodic contraction induced by acute inflammation, and the dilatation we must, from ascertained phenomena, presume to be induced by absolute darkness long continued. Its inferior

power of contraction in children, and the increase of its power by exercise, as in artisans incessantly employed upon minute objects, in which it is apt to acquire a rigidity which scarcely admits of dilatation. — Its obedience, in all respects, to the laws which regulate the muscular system. — Its contractility in proportion to the strength and perfection of the nerve of sense with which it is associated. — Its incapacity of perfect contraction when tremulous, and its spastic contraction, even to the resistance of the influence of belladonna, in tetanus.—Its relaxation when the sphincters are relaxed, as in syncope, asphyxia, apoplexy, or compression of the brain, and after the use of alcohol in excess.—Its complete dilatation when under the influence of the sedative poisons, as opium, hyosciamus, belladonna, &c., to which its proper nerves are in a peculiar manner irritable.

Iris partly elastic.—The ciliary portion of the iris I regard as an elastic structure. It is by virtue of its elasticity that the extraordinary dilatation of the pupil, such as we see under the use of belladonna, is produced. Here, as in other parts, elasticity is opposed to muscular motion ; hence, when the latter is paralysed, or from any cause diminished, the former strikingly predominates ; when the nervous supply is intercepted, the pupil gapes widely, the action of elasticity being independent of the sensorium.

Pupils of animals.—All animals which have a moveable iris have the pupil circular, oblong, or elliptical, forms favourable to the arrangement of marginal fibres. In fish, the iris is evidently a prolongation of the choroid without interruption of continuity ; it is therefore mo-

tionless. Mr. Travers concentrated the rays of the sun in the focus of a pocket lens, and threw them upon the pupil of a perch, at the moment of drawing it from the water; it underwent no change. In other animals it contracted to a line, vertical (cat), or horizontal (adder, toad), according to the figure of the pupil; or to a small pin's head aperture, where it was of a circular form, as in the common snake.

Mr. Travers's theory.—"If we look through the vitreous humour exposed for a small space on its posterior surface, we observe the plicæ advancing upon its anterior surface beyond the margin of the lens, like a circular fan or screen; if the lens is pressed evenly backwards, the plicæ separate and extend the sacculated circle of Petit, to which their edges are affixed. On remission of the pressure, the lens springs forward and the leaves of the fan are closed. The circumferential compression of the globe increases the closeness of their application. In the dead body, only the most coarse and remote analogies can be obtained to the functions of the living. But I cannot believe so obvious, and yet so exquisite, a contrivance for changing the site and figure of the apparatus, as this view affords, can be without necessity or occasion. Looking, then, at the posterior origin of the processes from the choroid, and their attachment externally to the ciliary ring; their insertion into the vitreous capsule to the edge of the fossula, their encroachment upon the anterior segment of the crystalline, and their termination by distinct prolongations in the substance of the iris at its great circumference; assuming the choroid and annulus as fixed points, and the iris and processes as the move-

able parts of the apparatus, it follows that the plicæ will be unbraced and partially open in the state of mean dilatation of the pupil belonging to passive or atonic vision, and in the state of extreme dilatation of the pupil, accompanied with blindness to near objects, totally relaxed and floating.

"On the contrary, by the steadily contracted state of the pupil suited to the nearest extremity of the focal range, they will be closed and braced together; and, bearing upon the circumference of the crystalline at every point, will necessarily elongate the axis of the lens. These being the extreme states, so in proportion the intermediate degrees of adaptation will be accounted for. Hence the actions of the pupil, however excited, will extend their influence to the lens, and by this catenation of motions the general conformity of adjustment to light and adaptation to distance are to be explained. And this forms no objection to the hypothesis, because it is only in the voluntary and steadily preserved contractions of the pupil that the latter object is or can be required; for blindness would as surely ensue from gazing on the sun, as death from suspending the actions of the respiratory muscles, were it in our power to do either; and therefore the involuntary has the ascendancy over the voluntary action in both these cases, as it has in all cases of mixed muscles."

Uveal prolongations of the ciliary processes.—Radiated fibres are described by Haller and Zinn as raised on the posterior surface of the iris, and advancing even to the margin of the pupil. They are distinct from those seen on its anterior surface, and regarded as continuations of

the ciliary processes. In man no such fibres are distinguishable by the naked eye ; but if the observation, however obtained, be correct, it affords a strong presumption in favour of the power of the iris to change the figure of the lens by the instrumentality of the plicæ. The capsule, it is true, is fixed by the processes, but this opposes no obstacle to the change proposed ; for the membrane of Petit, to which alone the processes are affixed, is relaxed when they are closed, and extended when they are separated, and thus permits the capsule to yield only in the degree required for the change of the lens ; or, in other words, preserves its exact adaptation to the face of the lens in its opposite and varying states. This I take to be the use of the membranous circle of Petit, that it gives the processes the complete command of the continuous capsule.

Dilatation of the pupil, with bulging of the lens.—Some cases of dilated pupil are accompanied by a bulging of the lens. This is not the effect, but the cause, of dilatation, for it never follows the application of belladonna, provided the capsule be entire ; but if from any cause the lens be protruded so as to bear down the natural resistance of the processes, the pupil becomes dilated by its pressure.

It is believed by many, that the motions of the iris in animals are single, and obedient solely to the stimulus, and that they have no control over the pupil by volition ; a property which pertains exclusively to the adjusting power, and which is exerted independently of the variation of light. It is probable that they possess it so far only as it results from the adaptation to light. Notwith-

standing, upon watching the eye of a cat or of a hawk, the contraction of the pupil often appears to be voluntary. When the eye of the animal is bent upon an object that excites its attention, yet which does not shift its position, the pupil may be seen to enlarge and contract alternately. The animal is probably employed in examining the object under different lights, by intentionally admitting more or fewer rays through the pupil.

The iris is a mixed muscle; its motions are regulated in part by the stimulus of light upon the retina, and in part by an effort of the will.

Involuntary actions of the iris.—That the motions of the iris which take place upon the sudden changes of light are involuntary, there can be no doubt, for they are observed even in sleep, when the will cannot be exerted, and in the earliest infancy. There is another proof that these motions are involuntary, viz., that they occur in some forms of perfect amaurosis. The pupil has been observed to act briskly, where the person has been totally devoid of the perception of light from bright sunshine, or the flame of a candle held before his eye.

The sympathy of the iris with the retina must be ascribable to a communication between the retina and the ciliary nerves which supply the iris. The small lenticular ganglion, from which these are derived, lies upon the optic nerve, and is probably the medium of communication.

Voluntary motion of the iris.—On the other hand, every one may satisfy himself of a power which the will is capable of exercising over the iris, in alternately viewing near and distant objects; the state of relaxation or

moderately dilated pupil being suited to the remote, and its tonic or relatively contracted state to the near object. It is seldom that this change is sufficient to be obvious to a bystander where the light remains unchanged, because the faculty is seldom exercised in these circumstances; and still more rare for the state of accommodation to be preserved in defiance of the changes of light, because it is an unnatural effort. I have several times observed, in persons whose eyes were steadily fixed upon an object at some yards' distance, that the approach of a candle towards the eye did not stimulate the pupil to contraction, until it was so placed as that its image should fall upon the most sensible part of the retina, when the pupil instantly contracted. So that the voluntary is in subordination to the involuntary, where they are opposed; that is, when the stimulus of light opposes the adaptation of the eye to distance. But by continued application, the mind is capable of acquiring an extraordinary power over the motions of the iris, as is well known to be the case with other muscles subjected in any degree to volition. Of this, Dr. P. M. Roget presents a remarkable illustration, as shown by the following description of the power which he possesses of contracting or dilating the iris at pleasure.

"When I have stated that I possessed the power of dilating and contracting the iris at pleasure, the fibres of which are usually considered as no more under the dominion of the will than the heart or blood-vessels, my assertion has, in general, excited much astonishment. Such, however, is strictly the fact. I can easily satisfy any person who witnesses the movements I can produce

in them, that this power is totally independent of the influence of light, since I can effectually exert it, although the position of my eye, with regard to the window or candle, as well as the direction of the optic axis, continues unchanged. However singular this power may appear, it admits, I conceive, of a very natural explanation. The effort, of which I am concious, when performing the voluntary contraction of the pupil, is the same as that which accompanies the adaptation of the eye to short distances, and is of course productive of an increase of its refractive power. This very same power of moving the iris in fact is possessed, in a greater or less degree, by every person who enjoys the faculty of distinct vision at different distances. It is accordingly well known, that if a person, after looking at a distant object, transfer his attention to a near object, the pupil always contracts. But this change, it is supposed, can never be effected, unless some real object or image, from which light radiates, be present to direct the sight. I have never, indeed, met with any person besides myself, who, while steadily directing his eye to a distant object, and while no other object intervened, could, by a mere effort of the will exerted on the eye, augment its refractive power so as to adapt it to the vision of near objects. That I have acquired such a power I can ascribe to no other cause than to my having, from my childhood, been much in the habit of observing optical phenomena, and of practising various experiments relating to vision, a subject which I early took great delight in cultivating.

" It is still more easy for me, while an object is placed near my eye and distinctly seen, immediately to relax

the organ so as to fit it for the distinct vision of the most distant objects; and these changes I can effect in succession with considerable rapidity, each change being accompanied with a corresponding enlargement or diminution of the pupil. The increasing the refracting power of the eye, is always the change that constitutes the effort; the state of vision adapted to parallel rays being that of complete relaxation. The effort which attends this voluntary contraction of the pupil, when there is no object before the eye to call for such a change, is followed by a sense of fatigue; and if often repeated, or too long continued, it becames painful, and continues so for a long time afterwards. The fatigue is felt almost exclusively in the eye to which my attention had been directed during the experiment, although the same change takes place in the refractive power, and I believe to the same extent, in the other eye. It is also remarkable, that when there exists a real object of sight which is looked at, and which requires an equal change in the eye for distinct vision, as in the former case, no sense of fatigue, or hardly any, is experienced.

"I need scarcely add, that while I thus alter the refractive power of my eye from that which adapts it to the *distance* of the objects which I look at, these objects appear indistinct, from their images either forming before the rays reach the retina, or tending to form beyond it."

Nerves of the iris.—In addition to the nerves derived from the lenticular ganglion, the iris receives two or more branches from the nasal nerve (fifth pair), and its actions may possibly be subjected to the will by virtue of the influence which these nerves convey, for from the same

source is derived the nerve which supplies the levator palpebræ, which is purely voluntary.

The limited motion which the pupil has when the retina is for the most part insensible, may be considered as an involuntary or automatic motion, similar to that which in a healthy eye affords protection to the retina ; and if, as sometimes happens, the iris contracts in a state of blindness, this likewise must be regarded as its involuntary action, for volition cannot precede sensation. It is probable that those motions of the iris, which are in conformity to the impressions of light upon the retina, are purely involuntary ; and that those which are in conformity to the situation of objects, and are therefore directly subservient to vision, are under the influence of the will. Hence the dependence of the adjusting faculty upon the perfection of the retina.

Various conjectures have been entertained respecting the functions of the ganglia ; some have supposed that they were intended as bars or stops upon volition, and cited the iris, which they supposed to be purely involuntary, in support of their hypothesis. By others, ganglia have been supposed to be small *sensoria* or cerebral receptacles, capable of rendering a supply of nervous energy to their filaments, by which they are in a measure independent of the brain and its appendages. Mr. Travers attributes the voluntary motions of the iris to nerves unconnected with ganglia ; the involuntary to those derived from the lenticular ganglion, which he regards as a direct medium of communication between these nerves and the retina.

On account of the obscurity which envelopes the actions of the third, fourth, and sixth nerves of the orbit, I in-

sert the following extract from Professor Müller's work, as translated by Dr. Baly, in order that the reader may, at all events, be put in possession of all the facts known up to the present time, if it does not remove the obscurity in which the subject is involved.

ON THE PECULIAR PROPERTIES OF THE NERVES OF THE EYE.

"We are ignorant as to whether the third, fourth and sixth nerves have sensitive in addition to their motor power. Desmoulins asserts that, when they are stretched or pinched, no pain is produced; but it is difficult to determine this with regard to such small nerves, and after the violence that is necessarily done to the animal in laying them bare.

"The third nerve supplies the levator palpebræ muscle, the superior, inferior, and internal recti, and the inferior oblique; and from its branch to the latter muscle the ciliary or lenticular ganglion derives its short root, while the long root of this ganglion is supplied by the nasal nerve of the fifth, and contains a filament from the cavernous plexus of the sympathetic.

"The influence of the third nerve and that of the nasal nerve on the iris, deserves a special consideration. Desmoulins relates that, according to the experiments of Fowler, Reinhold, and Nysten, the application of galvanism to the third nerve causes a contraction of the iris. The excellent enquiries of Mr. Mayo have shewn that the motions of the iris are regulated by the third nerve through the medium of the short root of the ciliary ganglion, and that the long root of this ganglion, derived from

the nasal branch of the fifth, has no influence over the motions.

" The following are the results of his experiments on thirty living pigeons, in which birds M. Muck has shown that the ciliary ganglion has two roots, one from the third, the other from the fifth nerve.

" 1. When the optic nerves are divided in the cranial cavity of a living pigeon, the pupils become fully dilated, and do not contract on the admission of intense light. (Magendie also observed dilatation of the pupil, and immobility of the iris, as a consequence of division of the optic nerve in dogs and cats; while the pupil became contracted, and the iris immoveable when the same experiment was performed on rabbits and guinea-pigs.)

" 2. When the third pair of nerves is divided in the cranial cavity of a living pigeon, the same result ensues; in both these cases the surface of the eyeball retains its feeling.

" 3. When the fifth nerve has been divided on one side in the cranial cavity of a living pigeon, the iris on that side contracts as usual on the admission of light, but the surface of the eye appears to have lost its feeling (which it derived from twigs of the ophthalmic branch of the fifth).

" 4. When the optic nerves are pinched in the cranial cavity of a living pigeon, or immediately after its decapitation, the pupils are contracted for an instant on each injury of the nerves. (A phenomenon observed by Flourens also.)

" 5. When the third pair of nerves is irritated in the living or dead bird, a like result ensues.

" 6. When the fifth nerve is similarly irritated in the dead bird, no affection of the pupil is observed.

"7. When the optic nerves have been divided within the cranial cavity of a pigeon, immediately after its decapitation, if the portion of the nerves attached to the eyes be pinched, no contraction of the pupil ensues: if the portion adhering to the brain be pinched, a like contraction of the pupil ensues as if the optic nerve had not been divided.

"8. The previous division of the fifth pair of nerves in the preceding experiment produces no difference in the result.

"9. When the third nerves have been divided in the cranial cavity of the living or dead bird, no change in the pupil ensues on irritating the entire or divided optic nerves.

"From these experiments we may with confidence conclude, that the motor power of the ciliary ganglion and nerves is derived from the third nerve, and that the light does not cause the contraction of the pupil by acting directly on the ciliary nerves; but that the irritation of the retina and optic nerve acts immediately upon the brain, and from the brain is reflected upon the third nerve, and the short motor root of the ciliary ganglion. This might be inferred also from the well known circumstance that, in an eye amaurotic from paralysis of the retina, the direct action of light does not cause contraction of the iris, but that the iris of this same eye still acts when the light is directed upon the other sound eye. Mayo's experiments show, moreover, that the general sensibility of the eye is given to it by the fifth nerve, the ophthalmic branch of which sends filaments to the conjunctiva, while the long root of the ciliary ganglion, from the nasal branch of the fifth, supplies the interior of the eye with sensibility.

"The nutrition of the eye is under the influence of the sympathetic twigs: we have already seen what an influence the sympathetic ganglion has over the nutrition of the eye; and that, after the superior cervical ganglion has been destroyed, inflammation of the eye with effusion ensues. M. Majendie found, that division of the fifth nerve in rabbits, guinea pigs, dogs, and cats, was followed by immobility of the iris, with dilatation of the pupil in dogs and cats, contraction of it in rabbits and guinea-pigs. These effects must depend on a reflected action through the medium of the brain. We can now enquire into the mode in which the third nerve influences the motion of the iris, a point respecting which I have made several original observations.

"The third nerve, when excited to action, voluntarily or involuntarily, frequently gives rise to contraction of the iris. Since the third nerve supplies all the recti muscles, with the exception of the rectus externus, we know that when the eye is voluntarily directed outwards, the third nerve is not active, and that it is so when the eye is voluntarily turned inwards. If one eye be closed and the other turned inwards, we may perceive that the pupil becomes contracted, and that it becomes dilated if the eye be directed outwards, the intensity of the light remaining the same. Hence it inevitably follows, that every voluntary motion of the eye, in which the branch of the third nerve to the internal rectus is engaged, is accompanied by action of the iris; and that, when the sixth nerve is acting, the iris is inactive, the pupil dilated.

If one eye be turned outwards, the other inwards, no remarkable change in the state of the pupil is observable

on account of the opposite conditions of the two eyes. If the axes of the eyes are made to converge in a considerable degree, as in looking at a near object situated at the side, or directly in front, the contraction of the pupil becomes very great; on the contrary, the more parallel the direction of the eyes, and the less the internal recti muscles, which are supplied by the third nerve, are determined to action, the wider does the pupil become.

"Hence we have voluntary power over the motions of the iris; in other words, whenever the third nerve is excited to action by volition, the iris contracts. Now, in looking at near objects the axes of the eyes are made to converge,—the eyes are turned inwards; and hence, when we direct our eyes to near objects, the pupil becomes much contracted, and dilates when we look at distant objects. The motions of the iris in birds are not really more subject to the will than in man; the pupil becomes very narrow in birds, when we approach them and they become agitated.

"It is not, however, the branch of the third nerve which goes to supply the internal rectus muscle only, that has this sympathetic influence over the iris; other branches, and particularly that which supplies the inferior oblique muscle have the same power. The inferior oblique muscle rotates the eye so as to carry the pupil upwards and inwards: if this movement is executed voluntarily, the pupil becomes much contracted. The eye takes this position involuntarily when sleep is coming on, in sleep itself, in the state of intoxication, and in hysterical attacks; hence we find the pupil contracted during sleep.

"The contracted pupil of sleep can, however, be made to contract still more by the admission of intense light,

according to the observation of Mr. Hawkins. At the moment of waking, the pupil, after a few irregular contractions, assumes its usual degree of dilatation.

" The facts drawn from *comparative anatomy* are generally confirmatory of the foregoing physiological results. The ciliary nerves are constantly supplied from the third nerve, and nasal branch of the fifth. The following varieties are met with :—

" 1. Branches of the third and nasal nerves unite as roots to form the ciliary ganglion. The ciliary nerves arise in part from the ganglion, and in part from the nasal nerve itself. This is the arrangement of the nerves according to the extended and accurate researches of M. Muck and Tiedemann in the dog, hare, ox, sheep, goat, deer, roe, hog, owl, pigeon, parrot, goose, turkey, and plover, (in the turtle also, according to Bojanus).

" 2. The ciliary ganglion connected more immediately with the root derived from the third nerve ; the ciliary nerves arising from it, going partly to the eye directly, and partly uniting in a looped manner with ciliary branches of the nasal nerve, some filaments of which are continued separately to the eye. This structure has been found in the cat, falcon, heron, raven, cock, duck, merganser, and tern. I regard this form merely as a variety of the former.

" 3. In the rabbit, Muck found no connection of the third and nasal nerves forming roots of a ganglion ; both those nerves gave off ciliary twigs separately. According to Retzius, the ciliary ganglion is here situated nearly within the sheath of the third nerve.

" 4. Desmoulins asserts that the nasal nerve gives off

no ciliary branches in the rabbit, guinea-pig, and water rat: all the ciliary nerves, in these animals, being derived from the third: he also states that the ciliary ganglion is absent in them, as in all rodent animals?

"5. No animal with a moveable iris fails to receive ciliary branches from the third nerve, which is always one of their principal sources when the iris is endowed with motion. M. Muck and Tiedemann asserted, it is true, that in the horse the ciliary ganglion is absent, and that the motor oculi nerve gives off no ciliary branches; but Retzius has discovered a very minute ganglion and its two roots, one derived from the third. Muck is probably in error, likewise, in stating that in the squirrel, also, none of the ciliary nerves are derived from the third nerve.

"6. In fishes, the iris is nearly universally immoveable. Muck and Tiedemann found ciliary in the salmo hucho, which arose from the third nerve, and from the nasal, and in part anastomosed with each other: in the carp, the ciliary nerves arose from the third pair. From the researches of Professors Schlemm and D'Alton, it appears that fishes do not differ from other animals in respect to the ciliary, which they found to be generally derived from the usual roots.

"7. In mammalia, the sixth nerve gives filaments to the musculus suspensorius, as well as to the external rectus; and in birds, to the muscle of the membrana nictitans.

"8. In cetacea, according to Rapp and Burns, the fifth nerve also gives branches to the muscles of the eye, the special nerves of those muscles being likewise present.

Schlemm and D'Alton found the same to be the case in the petromyzon or lamprey.

"9. In the lampreys there are, according to Schlemm, two special nerves for the muscles of the eye; namely, the motor oculi, and trochlearis, which unite in the orbit.

"10. In the myxinoid fishes, the third, fourth, and sixth cerebral nerves are wanting, as well as the muscles of the eye.

"*Influence of the brain on the motor nerves of the eye.*—Desmoulins and Majendie state that, when the peduncle of the cerebellum is divided in mammalia, the eye of the corresponding side is directed downwards and forwards, the eye of the opposite side upwards and backwards; section of the pons varolii was attended with the same result."

CORRECTIVE AND ACHROMATIC POWER OF THE CRYSTALLINE LENS.

It has been shown that part of the rays which are dispersed by *spherical aberration*, are arrested in their progress by the iris: this aberration is still further corrected by the peculiar structure of the lens, the refractive power of which is so adjusted to that of the contiguous aqueous and vitreous humours, as to correct the aberrations which the figure of the cornea would occasion, and to throw the most oblique rays with sufficient accuracy upon the concave surface of the retina. Not only is the clearness of the image undisturbed by superfluous light, but it is also destitute of colour, the decomposition of light by irregular refraction, being in ordinary vision prevented or corrected by the structure and curvature of the crystalline lens.

Light, artificially separated, either by refraction, reflection, or inflection, produces colour; but the light which arrives at the eye in its natural combination of elementary rays, undergoes no such decomposition in its passage through the humours.

According to Dr. Brewster this is not strictly the case, who says that no provision is made in the human eye for the correction of colour, because the deviation of the differently coloured rays is too small to produce indistinctness of vision. If we shut up all the pupil excepting a portion of its edge, or look past the finger held near the eye, till the finger almost hides a narrow line of white light, we shall see a distinct prismatic spectrum of this line containing all the different colours; an effect which could not take place if the eye were achromatic.

USE OF THE CHOROID AND BLACK PIGMENT.

For perfect vision with the human eye, it seems requisite that the rays of light should undergo no reflection after reaching the retina. To provide for this object, the delicate membrane called the choroid, which immediately contains the retina, secretes in the human eye a black mucus called the pigmentum nigrum, which has the effect of absorbing the rays of light that have once reached the retina. Those in whom this black pigment is wanting, have a weak sight, and only see distinctly in an obscure light. We may suppose the retina in such cases liable to be dazzled by the reflection of part of the light from the vascular choroid. On the other hand, there are animals which habitually seek their prey in the dark; in these and in several instances where the final

cause of the peculiarity of structure is not equally obvious, the back part of the choroid is covered with a membrane termed the *tapetum lucidum*, which presents a brilliant reflecting surface. The lustre of the eyes of cats in an obscure place results from this cause. It is supposed that the double impression of a low degree of light upon the retina may be equivalent to the single impingement of brighter light. M. Majendie ingeniously compares with this disposition of parts, a structure observed by himself in the eyes of birds remarkable for their acute vision. In the eagle, the retina lies in numerous folds, so that we may suppose it several times perforated by the rays of light.

The eye of the Albino is remarkable for its want of pigmentum nigrum, in consequence of which the pupil and iris are coloured of different shades of red. In such persons vision is weak in the ordinary light of day, and distinct only in a darkened room, or at twilight. The eyes of Albinoes are likewise observed to be in continual motion, unconsciously oscillating from side to side, even when their sight is most steadily bent upon an object. There can be little doubt that this provision is intended to save the unprotected retina, by preventing a continual impression of undue intensity upon one point. Other people use one part of the retina for perfect vision and direct it successively towards the different points of an object while examining it; the Albino uses several, continually alternating from one to the other. The motion is unattended with any apparent change of place in the object, (such as that which occurs when the eye is pushed or drawn aside,) upon the same principle as when for experiment's sake we intentionally roll the eye from side to side; the scene before

us in either case remains visibly stationary, because the parts of the retina upon which each point of an object is successively delineated, are in their turn brought opposite to the same point in space.

THE SEAT OF VISION.

The action of the retina is a vital one, the mechanism of which is completely unknown ; it being the surface on which the refracted rays are converged to a focus, for the purpose of conveying an impression to the brain. The retina receives the impression of light when it is within certain limits of intensity.

When the eye is steadily directed to objects illuminated by a very faint gleam of light, it is thrown into a state of painful agitation. A kind of remission takes place in the conveyance of the impressions along the nervous membrane ; the object actually disappears, and the eye is agitated by the recurrence of impressions which are too feeble for the performance of its functions.

When too strong a light has suddenly struck the retina, the impression is called *dazzling*, and the retina is incapable for a few moments afterwards of discovering the presence of light. This happens when we endeavour to look steadily at the sun. When we have been long in the dark, even a faint light causes dazzling.

If the light which reaches the eye is extremely weak, and we endeavour to fix objects, the retina becomes very much fatigued, and we soon experience a painful sensation in the orbit, and even in the head.

The field of vision is limited.—When we look intensely at any object in order to examine it with care and atten-

tion, we direct to that point the axis of the eye, and consequently, the image of that point falls upon the central hole in the retina; every other point of the same object is seen indistinctly, and the indistinctness increases with the distance of the point from that which is seen distinctly. The centre of the retina, therefore, appears to enjoy a more lively sensibility than the rest, and it is upon this part we throw the image, when we wish to examine an object with attention. This is not, however, confined to the axis of vision; for in certain positions of the eye, artificially induced, we have a clear perception of an object, from which the rays pass so obliquely, as to fall upon the retina not in the axis of vision.

Indistinctness of vision at the base of the optic nerve.—It was discovered by M. Mariotte, that when the image of any external object fell upon the base of the optic nerve, it instantly disappeared. In order to prove this, we have only to place upon the wall at the height of the eye, three wafers, two feet distant from each other, shutting one eye, stand opposite to the middle wafer, and while looking at the outside wafer, on the same side as the shut eye, retire gradually from the wall till the middle wafer disappears. This will happen at about five times the distance of the wafers, or ten feet from the wall; and when the middle wafer vanishes the two outer ones will be distinctly seen. If candles are substituted for wafers, the middle candle will not disappear, but it will become a cloudy mass of light. If the wafers are placed upon a coloured wall, the spot occupied by the wafer will be covered by the colour of the wall, as if the wafer itself had been removed. From this we learn, that there is a certain part of the retina less

sensible to ordinary impressions of light; further, this part may be shewn to be the base of the optic nerve, which is about the eighth of an inch in diameter.

Choroid seat of vision.—This circumstance induced Mariotte to consider the choroid as the seat of vision rather than the retina; for, argued he, there is no deficiency of that nervous matter of which the retina is an expansion, but the choroid is wanting. The opacity of the choroid coat and the transparency of the retina, which rendered it an unfit ground for the reception of images, were arguments in favour of this opinion. Comparative anatomy furnishes us with another argument, perhaps even more conclusive than any of those urged by Mariotte. In the eye of the *sepia loligo*, or cuttle fish, an opaque membranous pigment is interposed between *the retina and the vitreous humour*; so that, if the retina is essential to vision, the impressions of the image on this black membrane must be conveyed to the retina by the vibrations of the membrane in front of it. Now, since the human retina is transparent, it will not prevent the formation of images on the choroid; and the vibrations which they excite in this membrane, being communicated to the retina, will be conveyed to the brain. These views are strengthened by another fact of some interest. Sir D. Brewster has observed in young persons, that the choroid coat (which is generally supposed to be black, and to grow fainter by age) reflects a brilliant crimson colour, like that of dogs and other animals. Hence, if the retina is affected by rays which pass through it, this crimson light which must necessarily be transmitted by it ought to excite the sensation of crimson, which I find not to be the case.

The correctness of Mariotte's conclusions, on which this singular theory is founded, is extremely questionable. If, in his fundamental experiment of the three wafers, we substitute three candles, we then find, that though no image of the centre object is formed at this part, it is still not insensible to light, for a diffused reddish light appears to occupy the place of the flame. The base of the optic nerve therefore is not insensible to light, as Mariotte's hypothesis supposes; it is only unfit for giving distinct vision of those objects whose images fall upon it, in consequence of being placed on the projection of the central artery which accompanies it. The red nimbus results from the passage of light through this blood-vessel, the irregularity of which prevents it from transmitting the image.

Seat of vision in the vitreous humour.—A French writer, M. Lehot, has recently written a work endeavouring to prove that the seat of vision is in the *vitreous humour;* and that, in place of seeing a flat picture of the object, we actually see an image of three dimensions, with length, breadth, and thickness. To produce this effect, he supposes that the retina sends out a number of small nervous filaments, which extend into the vitreous humour, and convey to the brain the impressions of all parts of the image. If this theory were true, the eye would not require to adjust itself to different distances; and we besides know for certain, that the eye cannot see with equal distinctness two points of an object at different distances, when it sees one of them perfectly. M. Lehot might indeed reply to the first of these objections, that the nervous filaments may not extend far enough into the vitreous

humour to render adjustment unnecessary; but if we admit this, we would be admitting an imperfection of workmanship, in so far as the Creator would then be employing two kinds of mechanism to produce an effect which could have been easily produced by either of them separately.

Such are the theories that have been entertained respecting the seat of vision, and as difficulties still attach to every opinion respecting the seat of vision, we shall still adhere to the opinion most generally adopted; that the images of objects are painted upon the retina.

THE LAW OF DISTINCT VISION.

When the eye is directed to any point of a landscape it sees with perfect distinctness only that point of it which is directly in the axis of the eye, or the image of which falls upon the central hole of the retina. But, though we do not see any other point but one with that distinctness which is necessary to examine it, we still see the other parts of the landscape with sufficient distinctness to enable us to enjoy its general effect. The extreme mobility of the eye, however, and the duration of the impressions made upon the retina, make up for this apparent defect, and enable us to see the landscape as perfectly as if every part of it were seen with equal distinctness.

The indistinctness of vision for all objects situated out of the axis of the eye increases with their distance from that axis; so that we are not entitled to ascribe the distinctness of vision in the axis to the circumstance of the image being formed on the central hole of the retina, where there is no nervous matter; for if this were the

case, there would be a precise boundary between distinct and indistinct vision, or the retina would be found to grow thicker and thicker as it receded from the central hole, which is not the case.

Intermission in the vision of the objects seen obliquely. —In making some experiments on the indistinctness of vision at a distance from the axis of the eye, Sir D. Brewster was led to observe a very remarkable peculiarity of oblique vision. If when one eye is shut, we fix the other upon a point, such as the head of a pin stuck into a green cloth, and continue for some time looking at the pin-head, we shall see indistinctly all other objects within the sphere of vision. Let one of these objects be a strip of white paper or a pen lying upon a green cloth. After a short time, the strip of paper or pen will disappear altogether, as if it were entirely removed, the impression of the green cloth upon the surrounding parts of the eye extending itself over the part of the retina which the image of the pen or paper occupied. In a short time, the vanished image will reappear, and again vanish. The same effect is produced when both eyes are used; and when the object is highly luminous, like a candle, it does not wholly disappear, but expands itself into a mass of nebulous light, which is of a blue colour, encircled with a bright ring of yellow light.

From these results it appears that oblique or indirect vision is inferior to direct vision not only in distinctness, but from its inability to preserve a sustained vision of objects; but though thus defective it possesses a superiority over direct vision in giving us a more perfect vision of minute objects, such as small stars, which cannot be

seen by direct vision. This has been observed by several astronomers, both with regard to faint stars and to the satellites of Saturn. When the eye is turned full upon the star or satellite, it disappears; but when it is directed to another part of the field of the telescope, the luminous point will become distinctly visible. The following explanation of this singular phenomenon has been offered by Sir D. Brewster. A *luminous point* seen by *direct vision*, or a sharp line of light viewed steadily for a considerable time, throws the retina into a state of agitation highly unfavourable to distinct vision. If we look through the teeth of a fine comb held close to the eye, or even through a single aperture of the same narrowness, at a sheet of illuminated white paper, or even at the sky, the paper or the sky will appear to be covered with an infinite number of broken serpentine lines, parallel to the aperture, and in constant motion; and as the aperture is turned round, these parallel undulations will turn round also. These black and white lines are obviously undulations on the retina, which is sensible to the impressions of light in one phase of the undulation, and insensible to it in another phase. An analogous effect is produced by looking stedfastly, and for a considerable time, on the parallel lines which represent the sea in certain maps. These lines will break into portions of serpentine lines, and all the prismatic tints will be seen included between the broken curvilinear portions. A sharp point or line of light is therefore unable to keep up a continued vision of itself upon the retina when seen directly.

Now, in the case of indirect vision, we have already seen that a luminous object does not vanish, but is seen

indistinctly, and produces an enlarged image on the retina, beside that which is produced by the defect of convergence in the pupils. Hence a star seen indirectly, will affect a larger portion of the retina from these two causes, and losing its sharpness, will be more distinct.

These peculiarities of the retina with regard to vision, are, without doubt, the source of many optical deceptions, which have been ascribed to supernatural origin. In a dark night, when objects are feebly illuminated, their disappearance and reappearance must seem very extraordinary to a person, whose fear or curiosity calls forth all his powers of observation. This defect of the eye must have been often witnessed by the sportsman in attempting to mark, upon the monotonous heaths, the particular spots where moor-game had alighted. Availing himself of the slightest difference of tint in the adjacent heaths, he endeavours to keep his eye steadily upon it as he advances; but whenever the contrast of illumination is feeble, he almost always loses sight of his mark, or if the retina does take it up a second time, it is only to lose it again.

ON THE DURATION OF IMPRESSIONS OF LIGHT UPON THE EYE.

Every body must have observed that when we whirl a burning stick in the hand, a circle of light is seen marking out the parts described by its burning end. As the burning extremity can only be in one point of the path at the same instant, it is manifest that the impression of its light continues some time on the eye. In like manner, during the twinkling of the eye, or rapid closing of the eyelids for the purpose of diffusing the lubricating fluid

over the cornea, we never lose sight of the objects we are viewing. The most instructive experiment, however, on this subject, and one which it requires a good deal of practice to make well, is to look for a short time at the window at the end of a long apartment, and then quickly direct the eye to the dark wall. In general, the ordinary observer will see a picture of the window, in which the the dark bars are white and the white panes dark ; but the practised observer, who makes the observation with great promptness, will see an accurate representation of the window with dark bars and bright panes; but this representation is instantly succeeded by the complementary picture, in which the bars are bright, and the panes dark. M. D'Arcy found that the light of a live coal, moving at the distance of 165 seconds, maintained its impression on the retina the seventh part of a second. A friend of mine after viewing a brilliant gas light for some time, on going into a dark cellar, observed a distinct coloured spectrum of the gas light on the opposite wall, which lasted for upwards of three minutes. From these facts we learn, therefore, that the effect of light upon the retina continues for some time ; and that the period of its duration is proportionate to its primary intensity.

CAUSE OF SINGLE OR DOUBLE VISION WITH TWO EYES.

Hitherto we have considered sight in reference to vision with a single eye ; but habitually we employ both eyes. How happens it, then, that impressions made upon our two eyes at one and the same time are represented single to the sensorium. Of this, in the opinion of Mr. Travers,

we know as little as why we hear one sound with two ears, and smell one scent with two nostrils. He considers, that the mind is incapable of receiving two distinct impressions at the same instant; and that the simple experiment of Haller affords unexceptionable evidence of the fact, that we employ our eyes severally, and not at the same instant, in distinct vision, though the interval is too small to be measurable.

It is interesting to enquire what are conditions which render vision under these circumstances single or double. It is to be borne in mind that the centre of the retina, from whatever cause it proceed, furnishes the most distinct vision. Hence, in looking at a point of an object we invariably direct the axis of the eye towards it; and when we look with one eye at a succession of objects placed in a line directly before us, but at different distances, the optic axis is seen to incline inwards when we regard the nearest object, and to increase its direction outwards as we view those which are more remote.

Single vision.—Now when we look with both eyes at any one of such a series of objects, it appears single, the rest appear double. This familiar but remarkable phenomenon has given rise to the hypothesis that there are corresponding points in either retina; it is supposed that when an object is delineated upon those points of the two retinæ, which are naturally associated, it appears single, and double under other circumstances. But it seems unnecessary to resort to this explanation of the fact. There is no doubt that, in one sense, we really see two objects, but these objects appear as one, in consequence of the one occupying exactly the same place as the other. Single

vision with two eyes, or with any number of eyes, if we had them, is the necessary consequence of the law of visible direction. It has been already shown that objects are seen in a definite direction ; by the action of the external muscles of the eyeballs, the axis of each eye can be directed to any point of space at a greater distance than four or six inches. When therefore it happens, that the *visual direction* of an object is the same or nearly the same for both eyes, that object appears single ; when different, the object appears double. In both cases two objects are seen, but in single vision they are seen in the same place, and therefore necessarily appear to form but one ; the images coincide, and are therefore essentially indistinguishable. If, for example, we look at an aperture in a window shutter, we know that an image of it is formed in each eye ; but, as the line of visible direction from any point in the one image meets the line of visible direction from the same point in the other image, each point will be seen as one point, and, consequently, the whole aperture seen by one eye will coincide with or cover the whole aperture seen by the other. Were anything further wanting, to prove the correctness of this theory, the phenomena of double vision present themselves.

Double vision.—If the axes of both eyes are directed to a point beyond the window, or to a point within the room, the aperture will then appear double, because the line of visible direction from the same points in each image do not meet at the aperture. If when an object is seen single with both eyes, we press one eye aside, the image formed by that eye will separate from the other image, and the object will appear double : by pressure with the

finger we may raise or depress one eyeball, when the object seen by that eye appears to shift its place, as the position of the organ is varied. It is easy, therefore, by a very simple artifice to render vision double. The effect which is thus produced at will in an experiment, sometimes occurs as the result of disease. M. Majendie mentions the case of a gentleman in whom, from palsy of the third nerve, the left eye is permanently drawn outwards; the consequence of which, he observes, is, that with that eye the patient sees objects *in their wrong places*, " *déplacés de vingt à vingt cinq dégrés à droite de leur position.*" The case is curious, but not without its parallel, and the account of the result of the displacement of the eye is incorrect. It is not true that the object is seen by the averted eye *out of its true position;* the proof which is, that an eye thus affected, or similarly pushed aside for experiment's sake, will take as true an aim as before, or look along a line as justly towards a remote object. The object is seen apparently in two places, yet both eyes see truly. This paradoxical circumstance renders evident, one of the most curious provisions in our frame, namely, the extreme nicety with which the two eyes are coadjusted, so that their impressions may exactly tally. If the muscles of either of the eyes is unable to direct the two axes of the eyes to the same point, the object will in that case also appear double. This inability of one eye to follow the motions of the other is frequently the cause of squinting, as the eye which is, as it were, left behind, necessarily looks in a different direction from the other. The same effect is often produced by the imperfect vision of one eye, in consequence of which the good eye only is used. Hence

the imperfect eye will gradually lose the power of following the motions of the other, and will therefore look in a different direction.

A remarkable circumstance attending binocular vision, which was observed by Mr. Wheatstone, is the following. A solid object being placed so as to be regarded by both eyes, projects a different perspective figure on each retina; now if these two perspectives be accurately copied on paper, and presented one to each eye so as to fall on corresponding parts, the original solid figure will be apparently reproduced in such a manner that no effort of the imagination can make it appear as a representation on a plane surface. This and numerous other experiments explain the cause of the inadequacy of painting to represent the relief of objects, and indicate a means of representing external nature with more truth and fidelity than have yet been obtained.

ESTIMATION OF SIZE AND DISTANCE OF BODIES.

Every object at which we look must have a definite visual magnitude, inasmuch as the apparent size of an object must exactly depend upon the space which its outline occupies upon the retina. Now the same object at different distances will, it is easily shown, occupy a larger or a smaller area in the retina. The nearer it is, the larger will be that area; the more remote, the less. Here then is a provision by means of which we may learn to judge of the relative distance of a known object. But does the eye possess any absolute power of determining the actual distance, magnitude, and position of objects? It would appear, from the following interesting case re-

corded by Cheselden, that such knowledge is relative, and results from the experience derived from the combined agency of the senses of sight and touch. This philosophic surgeon, after performing the operation of couching, studied the effect of the first visual impression upon his patient, which he describes in the following words:—

"This young gentleman either had been born blind, or had lost his sight so early that he had no remembrance of ever having seen: the blindness arose from a cataract or opaque crystalline lens in both eyes. Like other persons who have ripe cataracts, he was not so blind but that he could discern day from night, and for the most part in a strong light, distinguish black, and white, and scarlet. When he first saw, he was so far from making any judgment about distances, that he thought all objects whatever touched his eye, (as he expressed it,) as what he felt touched his skin. He knew not one thing from another, however different in shape or magnitude: but upon being told what those things were, whose form he knew before from feeling, he would carefully observe that he might know them again. Two months after being couched, his attention seems to have been drawn to the effects of painting, which he then first and at once comprehended; but even then he was no less surprised, expecting the pictures would feel like the things they represented, and was amazed when he found those parts, which by their light and shadow appeared round and even, felt only flat like the rest; and asked which was the lying sense, feeling or seeing?

"Being shown a small miniature of his father, and told

what it was, he acknowledged a likeness, but was vastly surprised, asking how it could be that a large face could be expressed in so little room, saying it should have seemed as impossible to him, as to put a bushel into a pint. At first he could bear but very little light, and the things he saw he thought extremely large, but upon seeing things larger, those first seen he conceived less, never being able to imagine any lines beyond the bounds he saw. The room he was in, he said, he knew to be but part of the house, yet he could not conceive that the whole house could look bigger. Before he was couched, he expected little advantage from seeing worth undergoing an operation for, except reading and writing; for he said, he thought he could have no more pleasure in walking abroad than he had in the garden, which he could do very safely and readily; and even blindness, he observed, had this advantage, that he could go anywhere in the dark much better than those who can see; and after he had seen, he did not soon lose this quality, nor desire a light to go about the house in the night. He said every new object was a new delight, and the pleasure was so great that he wanted ways to express it; but his gratitude to Mr. Cheselden he could not conceal, never seeing him for some time without tears of joy and other marks of affection. A year after first seeing, being carried upon Epsom Downs, and observing a large prospect, he was exceedingly delighted with it, and called it a new kind of seeing. And now being lately couched of his other eye, he says that objects at first appeared large to this eye; but not so large as they did at first to the other; and looking upon

the same object with both eyes, he thought it looked about twice as large as with the first couched only, but not double that he can anyways discover."

From these details we learn, that originally we derive no information respecting either the distance or real magnitude of bodies from the sense of sight, and that there is no essential resemblance between the ideas communicated by vision and by feeling. The infancy of man's existence is employed in learning to interpret the visible signs of external objects. For this purpose, as soon as there is intelligence in an infant's gaze, it extends its hands to touch and examine each object in succession which attracts its notice.

The eye has no original measure for distance, and gives us no certain notion of real magnitude. When the eye is fixed upon a point on the wall of a narrow chamber, or in the vault of heaven, it seems to command an oval or circular area of equal visual dimensions; a foot rule under these circumstances held at the distance before the eye, measures equally the side of the room or a segment of the firmament.

When the actual size of an object is unknown to us, and we look at it, if at a certain degree of remoteness, with both eyes, *or if near, with one eye only*, we judge of its distance by the greater or less indistinctness of its outline and colour. We judge of its real magnitude by calculation founded upon its *apparent* size and probable distance. Hence we are liable to continual mistakes on these points. An Englishman, in the clear atmosphere of Italy, supposes distant objects to be nearer to him than they are. We think the moon larger when near the horizon than

when above our heads; near the horizon the moon is more dim, we therefore by analogy suppose her more remote; but her visual diameter being really the same, we therefore are persuaded that her disk is broader.

Estimation of the distance of objects.—We judge very differently of the distance of bodies according to its degree; we judge correctly when they are near, not when they are distant; then our judgments are frequently erroneous, but when objects are very distant we are constantly in error.

The united actions of both eyes is absolutely necessary in judging correctly of distance, as the following experiment will prove. Suspend a ring by a thread, and fix a hook capable of entering it easily, to the end of a long stick: place yourself at a proper distance, and endeavour to put the hook into the ring; if you use both eyes, you will succeed every time; if you shut one eye, you will not, the hook will go too far or fall short of the ring, and you will succeed only by chance and after much blundering; persons with eyes of unequal power, do not succeed even when they use both eyes.

If a person by accident loses an eye, he will sometimes be a year before he can judge correctly of the distance of bodies placed near him. In general, persons with but one eye judge imperfectly of distance. The size of the object, the intensity of its light, the presence of intermediate bodies, considerably influence our judgment of distance.

Our judgment is much more exact when objects are on the same level with ourselves. Thus, when we look from the top of a tower upon objects below, they seem much smaller than they appeared at the same distance,

when on the same level with ourselves. It is the same when we look at objects placed above. Hence the necessity of giving a considerable size to objects intended to be placed on the top of edifices and seen at a distance. The smaller the dimensions of a body are, the nearer it must be placed to the eye to be seen distinctly. We see a horse distinctly at the distance of "ten yards,"* but should not even descry a bird at that distance. If I wish to examine a hair or a feather of these animals, the eye requires to be very near. However, the same object may be seen distinctly at very different distances; for instance, it is indifferent to many persons, whether they place the book which they are reading at the distance of one or two feet from their eyes; the intensity of the light which illuminates an object has much influence upon the distance at which it can be seen distinctly.

Estimation of the size of bodies.—The manner in which we arrive at a correct judgment of the size of bodies, depends more upon the understanding and upon habit, than even upon the apparatus of vision.

We form our judgments relative to the dimensions of bodies, from the size of the image formed at the bottom of the eye, the intensity of the light which proceeds from the object, the distance at which we supposed it placed, and especially from our habit of beholding similar objects. For this reason we judge with difficulty of the size of a body which we see for the first time, when we do not consider its distance. A distant mountain, when first seen, generally appears much smaller than it really is; hence we believe ourselves near it, when in fact we are at a great distance.

* Magendie's Physiology translated by Dr. Forsyth.

Beyond a certain distance, we fall into an inevitable delusion: objects appear infinitely smaller than they really are; this happens with respect to the heavenly bodies.

Estimation of the motion of bodies.—We judge of the motion of a body by that of its image upon the retina, and by the variations of the size of this image, or what comes to the same thing, by the change of the direction of the light which reaches the eye. For us to be able to follow the motion of a body, it must not move too rapidly, for then we should not perceive it, as happens in projectiles sent by gunpowder, especially when they pass near us. When they move at a distance from us, as they send light to the eye for a long time, because the field of vision is larger, we easily perceive them. To judge correctly of the motion of bodies, we must not be in motion ourselves.

It is difficult to observe the motions of bodies at a distance. In fact, we judge of their motion, in this case, only by the variation in the size of the image. But as this variation, at a considerable distance is very small, it is very difficult, or even sometimes impossible, for us to estimate it. In general, we discover with difficulty slow motions of bodies; whether this effect depends upon the absolute slowness of motion, as in the case of the hour-hand of a watch, or results from the slowness of the motion of the image on the retina, as happens with the fixed stars or very distant objects.

ACCOMMODATION OF THE EYE TO DIFFERENT DISTANCES.

When the eye sees objects distinctly at a great distance,

it is unable, without some change, to see objects distinctly at a less distance. This will readily be seen by looking between the fingers at a distant object. When the distant object is seen distinctly, the fingers will be seen indistinctly; and if we look at the fingers so as to see them distinctly, the distant object will be quite indistinct.

It must be evident, then, that the rays of light which issue from an object at some distance from the eye, and those issuing from a much nearer object, cannot be collected into foci at the same given distance behind the crystalline lens, unless the eye have a power of altering its focal length. We know, moreover, that *perfect* vision is produced, only when the focal point is situate upon the retina: vision at different distances therefore cannot occur, unless the eye possesses a power of focal adjustment. The mechanism by which this focal adjustment is effected still remains in obscurity, notwithstanding the numerous attempts that have been made to explain it.

Various hypotheses.—I shall content myself with a very brief mention of the principal hypotheses to explain the adjusting action. To enumerate all with barely intelligible conciseness, would occupy a larger space than can be devoted to the subject. It has been ascribed to a change of figure in the cornea,--to the variations in the diameter of the pupil,—to a change of figure of the globe by the action of its muscles,—to a change of figure of the lens by an action proper to itself,—to a change of place of the lens by the contraction of the ciliary processes and the compression of the vitreous humour at its circumference.

The first supposes a close aponeurotic expansion derived

from the tendons of the recti muscles, bracing the anterior segment of the globe; the second assumes the muscularity of the iris, or the extension of its texture, by the sudden injection of its vessels, and vice versâ, its abridgment by their contraction; the fourth attributes muscularity to the crystalline; and the fifth attributes a similar structure to the ciliary processes.

Objections to some of the hypotheses.—An experiment made by Dr. Young, contravenes the supposition that the change produced consists in an alteration of the form of the cornea. A convex lens fixed in a socket, which contained water, and the edges of which were secured with wax, was applied to the eye, so that the cornea entered half way into the socket, and was every where in contact with the water: the eye immediately became *presbyopic;* but upon the addition of another convex lens to make up for the loss of the convexity of the cornea, vision was restored to its natural state, and the eye regained the power of adjustment.

The only evident change in the eye, when adjusting its focal length to different distances, is an alteration in the diameter of the pupil. The pupil enlarges when a distant object is seen, and diminishes when we look at a nearer point. Upon a superficial analogy we might conclude that these changes are sufficient to produce the requisite alterations of the focal length of the eye: for by viewing objects through a series of pin-holes in a card, the largest smaller than the aperture of the pupil, and each of the rest in succession smaller than the last, the eye is rendered capable of seeing distinctly at the distance of four, of three, and even two inches. When, however,

the correctness of hypothetical explanation is put to the test of direct experiment, it proves to be fallacious. 1st. Sir D. Brewster ascertained by direct experiment, that a variation in the aperture of the pupil, produced artificially, is incapable of producing adjustment. 2d. The following experiments of Professor Mayo may be adduced in confirmation. "A room was darkened by half closing the shutters, and I attentively observed the state of the pupil, when Mr. Robinson directed his eye to a definite point upon the optometer: the pupil was of course considerably dilated: the shutters being opened, the pupil instantly contracted, but the point upon the optometer at which the lines crossed, did not shift its place.

"When by some practice I had accustomed my own eye to the range of the optometer, I compared its range in the brightest and in the obscurest light in which the lines were visible, and observed no apparent difference in the two cases. Mr. Robinson made a similar observation. Either of these experiments prove that the change in the size of the pupil is not the means by which the adjustment of the eye to distances is effected. But an additional fact may be mentioned. In an old lady of sixty-seven, whose sight in early youth was remarkably good, but whose eyes can now only bring to a focus parallel rays, the pupil retains its mobility perfectly under variations of light, and even sensibly moves upon her making ineffectual attempts to read, without spectacles, a page held at different distances from her?"

As an elongation of the eye would alter the curvature of the retina, and consequently the centre of visible direction, and produce a change of place in the image, we

consider it quite untenable to suppose that the focal adjustment is effected by *an alteration in the figure of the eyeball.*

Dr. Young himself concludes that the means of adjustment consist in a change of form in the crystalline, the fibres of which he describes, and which he supposes to be irritable. But it does not appear from direct experiment that the crystalline possesses irritability; and if faith can be attached to a single well attested observation upon a point so delicate, the instance of Henry Miles, recorded by Sir Everard Home, proves that the eye may retain its power of adjustment after the removal of this humour.

The following inferences, which are the result of some experiments by Sir D. Brewster on this subject, appear to be most entitled to our consideration.

1st. The contraction of the pupil, which necessarily takes place when the eye is adjusted to near objects, does not produce distinct vision by the diminution of the aperture, but by some other action which necessarily accompanies it.

2d. That the eye adjusts itself to near objects by two actions; one of which is *voluntary*, depending wholly on the will, and the other *involuntary*, depending on the stimulus of light falling on the retina.

3d. That when the voluntary power of adjustment fails, the adjustment may still be effected by the involuntary stimulus of light.

Reasoning from these inferences, and other results of experiment, it seems difficult to avoid the conclusion that the power of adjustment depends on the mechanism which contracts and dilates the pupil; and as this adjustment is

independent of the variation of its aperture, it must be effected by the parts in immediate contact with the base of the iris. By considering the various ways in which the mechanism at the base of the iris may produce the adjustment, it appears to be almost certain that the lens is removed from the retina by the contraction of the pupil.

Cause of long-sightedness.—When the eye loses the power of accommodating itself to near objects the person is *long-sighted*, or *presbyopic*. This is owing to a diminution in the refracting power of the humours of the eye, on which account the rays of light from near objects, having a tendency to diverge, are not brought to a focal point upon the retina, but would, if continued on, come to a point some distance behind it: while rays from distant objects, being more nearly parallel, are capable of being brought to a focal point upon the retina. *Presbyopia*, according to some, is owing to a diminution in the quantity of the aqueous humour causing a diminished convexity of the cornea; according to others, it is due to a mechanical change in the state of the crystalline lens, by which its density and refractive power are altered. This change takes place most frequently at a particular part in the margin of the lens, and takes several months to go round. "If the human eye," says Sir D. Brewster, "is not managed with peculiar care at this period, the change in the condition of the lens often runs into cataract, or terminates in a derangement of fibres, which, though not indicated by white opacity, occasions imperfections of vision that are often mistaken for amaurosis, and other diseases. A skilful oculist, who thoroughly understands

the structure of the eye, and all its optical functions, would have no difficulty, by means of nice experiments, in detecting the very portion of the lens where this change has taken place; in determining the nature and magnitude of the change which is going on; in applying the proper remedies for stopping its progress; and in ascertaining whether it has advanced to such a state that aid can be advanced from convex or concave lenses. In such cases lenses are often resorted to before the crystalline lens has suffered an uniform change of figure or density, and the use of them cannot fail to aggravate the very evils which they are intended to remedy. In diseases of the lens, where the separation of fibres is confined to small spots, and is yet of such magnitude as to give separate coloured images of a luminous object, or irregular halos of light, it is often necessary to limit the aperture of the spectacles, so as to allow the vision to be performed by the good part of the crystalline lens.

It is easy, artificially, to obviate this defect of vision, when it is not accompanied by disease, by the employment of convex lenses, which, by compensating the diminished refractive powers of the humours, enables the eye to converge the pencils of light flowing from near objects to distinct foci on the retina.

Cause of short-sightedness.—When the eye is not able to see distant objects, and requires to bring minute objects very near it in order to be distinctly seen, the person is said to be *myopic* or *short-sighted.* This condition of vision is owing to the refracting powers of the humours being too great. The result is that parallel rays of light entering the pupil are brought to a focus before they reach the

retina; and having crossed, and begun to disperse again, are spread upon the retina in a circle instead of a point; and therefore the picture on the retina is indistinct. This imperfection often appears in early life, and arises from an increase of density in the central parts of the crystalline lens, or to an increased convexity of the cornea, owing to the presence of an undue quantity of the aqueous humour. By using a suitable concave lens, the convergence of the rays is delayed, so that the excessive refraction is corrected.

OCULAR SPECTRA.

The phenomena of ocular spectra or images of luminous objects remaining upon the retina after the external impression is withdrawn, are highly interesting and curious. Luminous sparks and flashes, halos or variously coloured rings, it is well known, are produced at will by friction or pressure of the closed eyelids, and the first are an instant effect of concussions of the brain. The red is that colour called up by the rudest artificial pressure; the violet by the slightest; and the gentlest impulse is the natural one, in which the light suffers no decomposition. Are these appearances really retinal impressions, or illusory mental phantoms, founded on the feeble and obscure analogy subsisting between mechanical pressure and the impression of light? Although blind persons perceive such appearances, it is doubtful if they ever present themselves in cases where the retina is disorganized, or after the extirpation of the eyeball, as the mutilated feel their fingers and toes. They seem therefore to establish the essential connexion between the retina and the faculty of

perception, or the connexion between the corporeal and mental impressions; and this is confirmed by what we observe of morbid spectra, which are symptoms of various disordered states of the retina to be treated of hereafter.

Accidental colours.—If the retina be fatigued by fixing the eye upon a coloured spot strongly illuminated, for some seconds, upon averting it the field of vision appears haunted by a spot of the size of that recently looked at, but of a different colour. If the experiment be repeated with different colours, the eye being directed, after each trial, to a perfectly white surface, the colour of the spectrum is found to have an invariable relation to the colour of the spot by which the eye has been fatigued. The secondary colour is called the convertible or accidental colour of the first.

In order to find the accidental colour of any colour in the spectrum, take half the length of the spectrum in a pair of compasses, and having set one foot in the colour whose accidental colour is required, the other foot will fall upon the accidental colour. This law of accidental colours, derived from observation, may be thus expressed: *the accidental colour of any primitive colour, is that colour which in the prismatic spectrum is distant from the primitive colour half the length of the spectrum.*

If we suppose the primitive colour to be reduced to the same degree of intensity as the accidental colour, then we shall find that the one is the *complement* of the other, or what the other wants to make it white light, that is, the primitive and the accidental colour when mixed together will make white light. Hence the *accidental colours* have also been called complementary colours. Since a mixture

of all the colours of the spectrum forms white light, it is obvious, that if one is left out, the mixture of the remainder will not be white light but some other tint. This other tint is found to be nearly that which corresponds to the centre of gravity of all the other colours which are left. So that if we arrange the colours of the spectrum in a circle, which is nothing more than the prismatic spectrum bent round till its two ends meet, we shall see that the centre of gravity of the colours which remain after one colour is omitted, must necessarily be opposite to the omitted colour, that is, the complementary colour is found in the same way as the accidental colour. Thus, if the *red* is omitted, the centre of gravity of the remaining arch will be in the blue.

With the aid of these facts, the theory of accidental colours will be readily understood. When the eye has been for some time fixed on the *red* wafer, the part of the retina occupied by the red image is strongly excited, or as it were deadened by its continued action. The sensibility to red light will therefore be diminished; and, consequently, when the eye is turned from the *red* wafer to the white paper, the deadened portion of the retina will be insensible to the red rays which form part of the white light from the paper, and consequently will see the paper of that colour which arises from all the rays in the white light of the paper but the red; that is of a *bluish green colour*, which is therefore the true complementary colour of the red wafer. When a *black* wafer is placed on a white ground, the circular portion of the retina, on which the black image falls, in place of being deadened, is pro-

tected by the absence of light, while all the surrounding parts of the retina, being excited by the white light of the paper, will be deadened by its continued action. Hence, when the eye is turned upon a white ground, it will see a portion whiter than the rest, so that the accidental colour of *black* is *white*.

Such are the phenomena of accidental colours when weak light is employed; but when the eye is impressed powerfully with a bright white light, the phenomena have a different character. The first person who made this experiment with any care was Sir Isaac Newton, who sent an account of his experiments to Mr. Locke, but they were not published till 1829. Many years before 1691, Sir Isaac, having shut his left eye, directed the right one to the image of the sun reflected from a looking-glass. In order to see the impression which was made, he turned his eye to a dark corner of the room, when he observed a bright spot made by the sun, encircled by rings of colours. This "phantom of light and colours," as he calls it, gradually vanished; but whenever he thought of it, it returned, and became as lively and vivid as at first. He rashly repeated the experiment three times, and his eye was impressed to such a degree, "that whenever I looked upon the clouds, or a book, or a bright object, I saw upon it a round bright spot of light like the sun: and, which is still stranger, though I looked upon the sun with my right eye only, and not with the left, yet my fancy began to make an impression on my left eye as well as upon my right; for if I shut my right eye, or looked upon a book or the clouds with my

left eye, I could see the spectrum of the sun almost as plain as with my right eye." The effect of this experiment was such, that Sir Isaac durst neither read nor write, but was obliged to shut himself completely up in a dark chamber for three days together; and by keeping in the dark, and employing his mind about other things, he began, in about three or four days, to recover the use of his eyes. This subject has been still further investigated by Æpinus; and since then Sir D. Brewster, who examined the brilliant image of the sun's disk formed by a concave reflector. With his right eye tied up, he viewed this luminous disk with the left through a blackened tube, to prevent any extraneous light from falling upon the retina. When the retina was highly excited by this intense light, he turned his left eye to a white ground, and perceived the following spectra by alternately opening and shutting the eye.

Spectra with the left eye open.	Spectra with the left eye shut.
1. Pink surrounded with green.	Green.
2. Orange mixed with pink.	Blue.
3. Yellowish brown.	Bluish pink.
4. Yellow.	Lighter blue.
5. Pure red.	Sky blue.
6. Orange.	Indigo.

Upon uncovering his right eye, and turning it to a white ground, he was surprised to find that it also gave a coloured spectrum, exactly the reverse of the first spectrum, which was pink with a green border. The reverse spectrum was green with a pinkish border. This experi-

ment was repeated three times, and always with the same results; so that it would appear that the impression of the solar image was conveyed by the optic nerve from the left to the right eye.

The phenomena of accidental colours are often finely seen when the eye has not been strongly impressed with any particular coloured object. It was long ago observed by M. Meusnier, that when the sun shone through a hole a quarter of an inch in diameter, in a *red* curtain, the image of the luminous spot was *green*. In like manner, every person must have observed, in a brightly painted room illuminated by the sun, that the parts of any white object on which the coloured light does not fall, exhibit the complementary colours. In order to see this class of phenomena, the following method appears the simplest and the best. Having lighted two candles, hold before one of them a piece of coloured glass, suppose bright red, and remove the other candle to such a distance that the two shadows of any body formed upon a piece of white paper may be equally dark. In this case one of the shadows will be *red*, and the other *green*. The same effect may be seen in looking at the image of a candle reflected from the water in a blue finger glass; the image of the candle is yellowish; but the effect is not so decided in this case, as the retina is not sufficiently impressed with the blue light of the glass.

These phenomena are obviously different from those which are produced by coloured wafers; because, in the present case, the accidental colour is seen by a portion of the retina, which is not affected, or deadened as it were,

by the primitive colour. A new theory of accidental colours is therefore requisite, to embrace this class of facts. The following is suggested by Sir D. Brewster.

"As in acoustics, where every fundamental sound is actually accompanied by its harmonic sound, so in the impressions of light, the sensation of one colour is accompanied by a weaker sensation of its accidental or harmonic colour. When we look at the *red* wafer, we are at the same time, with the same portion of the retina, seeing green; but being much fainter, it seems only to dilute the red, and make it as it were whiter, by the combination of the two colours. When the eye looks from the wafer to the white paper, the permanent sensation of the accidental colour remains, and we see a *green* image. The duration of the primitive impression is only a fraction of a second; but the duration of the harmonic impression continues for a time proportional to the strength of the impression. In order to apply these views to the second class of facts, we must have recourse to another principle; namely, that when the whole or great part of the retina has the sensation of any primitive colour, a portion of the retina, protected from the impression of the colour, is actually thrown into that state which give the accidental or harmonic colour. By the vibrations probably communicated from the surrounding portions, the influence of the direct or primitive colour is not propagated to parts free from its action, except in the particular case of oblique vision formerly mentioned. When the eye, therefore, looks at a white spot of solar light, seen in the middle of the red light of the curtain, the whole of the retina, excepting the

portion occupied by the image of the white, is in the state of seeing things *green ;* and as the vibrations which constitute this state spread over the portions of the retina upon which no red light falls, it will of course see the white circular spot green.

Colours produced by the unequal action of light upon the eyes.—A very remarkable phenomenon of accidental colours, in which the eye is not excited by any primitive colour, was observed by Mr. Smith, surgeon in Fochabers. If we hold a narrow strip of white paper vertically, about a foot from the eye, and fix both eyes upon an object at some distance beyond it, so as to see the slip of paper double, then if we allow the light of the sun, or the light of a candle to act strongly upon the right eye, without affecting the left, which may be easily protected from its influence, the *left* hand strip of paper will be seen of a bright *green* colour, and the right hand strip of a *red* colour. If the strip of paper is sufficiently broad to make the two images overlap each other, the overlapping parts will be perfectly white and free from colour, which proves that the red and green are complementary. When equally luminous candles are held near each eye, the two strips of paper will be white. If when the candle is held near the right eye, and the strips of paper are seen *red* and *green*, then on bringing the candle suddenly to the left eye, the left hand image of the paper will gradually change to *green*, and the right hand image to *red.*

Insensibility of certain eyes to particular colours.—A singular affection of the retina, in reference to colours, is shown in the inability of some eyes to distinguish cer-

tain colours of the spectrum. Various cases have been described, in which persons capable of performing the most delicate functions of vision, are unable to distinguish particular colours, and what is very remarkable, this imperfection runs in families. Mr. Huddart mentions, in the *Philosophical Transactions* for 1777, the case of Mr. Harris, a shoemaker at Allonby, in Cumberland, who was unable from his infancy to distinguish the cherries of a cherry-tree from its leaves, in so far as colour was concerned. Two of his brothers were equally defective in this respect, and always mistook *orange* for *grass green*, and *light green* for *yellow*. Harris himself could only distinguish black and white. Another case of a Mr. Scott is described by himself in the *Philosophical Transactions* for 1778; he mistook *pink* for a *pale blue*, and a *full red* for a *full green*. All kinds of yellows and blues, except sky blue, he could discern with great nicety. His father, his maternal uncle, one of his sisters, and her two sons had all the same defect. Mr. Harvey has described, in the Edinburgh Transactions, the case of a tailor, at Plymouth, whose peculiarity consisted in distinguishing with certainty only white, yellow, and grey: the solar spectrum he regarded as consisting only of yellow and light blue. He regarded indigo and Prussian blue as black. Mr. R. Tucker, son of Dr. Tucker, of Ashburton, mistakes orange for green; he cannot distinguish blue from pink, but always knows yellow. He describes the colours of the solar spectrum as follows:

1. Red . . . mistaken for . . . Brown.
2. Orange . . „ „ . . . Green.

3. Yellow	sometimes for	. . .	Orange.
4. Green	,,	,, . . .	Orange.
5. Blue	,,	,, . . .	Pink.
6. Indigo	,,	,, . . .	Purple.
7. Violet	,,	,, . . .	Purple.

Sir D. Brewster describes the case of a gentleman in the prime of life, who saw only two colours in the spectrum, viz., *yellow* and *blue*. Whenever the colours of the spectrum were absorbed by a reddish glass, excepting red and dark green, he saw only one colour, viz., yellow or orange, which he could not distinguish. When the middle of the red space was absorbed by a blue glass, he saw the black line with what he called the yellow on each side of it.

Our illustrious countrymen, Mr. Dugald Stewart, Dr. Dalton, and Mr. Troughton experience the same inability to distinguish certain colours.

In almost all these cases, the different prismatic colours have the power of exciting the sensation of light, and giving a distinct vision of objects, excepting in the case of Dr. Dalton, who is said to be scarcely able to see the red extremity of the spectrum.

In these various cases, the persons *are insensible to red light, and all the colours into which it enters.* Dr. Dalton thinks it probable that the red light is, in these cases, absorbed by the vitreous humour, which he supposes may have a blue tint. If, which is probable, the choroid be essential to vision, we may ascribe the loss of red light, in certain eyes, to the retina itself having a blue tint. Sir J. Herschel attributes this state of vision to a defect in the sensorium, by which it is rendered incapable of

appreciating exactly those differences between rays on which their colour depends. Should all these suppositions prove incorrect, we must, for the present, content ourselves with supposing that the retina is insensible to the colours at one end of the spectrum, just as Dr. Wollaston has proved the ears of certain persons to be insensible to sounds at one extremity of the scale of musical notes, while they are perfectly sensible to all other sounds.

VISION AT DIFFERENT AGES.

The eye is one of the first parts formed. In the fœtus they appear as two black spots; at seven months they are capable of modifying light, so as to form an image upon the retina; till this period the eyes could not fulfil the purposes of vision, because, till then, the pupil is closed by the membrana pupillaris. At seven months this membrane disappears; it is commonly said to split, but probably is absorbed. This too is the time when the fœtus can live. Fœtal eyes, however, are found, which at six, or even five months, offer no trace of this membrane.

There are some differences between the eye of the fœtus and adult, but they are not very remarkable. In the fœtus the sclerotic is finer, and even slightly transparent; the choroid is red without, and the black tint of its inner surface is less intense; the retina is proportionably more developed; the aqueous humour is more abundant, whence a greater projection of the cornea; lastly, the crystalline is far less consistent than in the

adult. Before birth the eyelids are close, as if they were glued together.

As age advances, the quantity of the humours insensibly diminishes, till the adult period; after this it diminishes in a more striking manner. This diminution is particularly evident in old age. The crystalline humour in particular becomes not only more dense, but inclines to a yellow colour, at first clear and afterwards deeper. While it undergoes this change, it acquires a greater hardness, and contracts a slight opacity, which may proceed with age till it amounts to a complete opacity.

The eye therefore is well adapted, in the new born infant, to act upon light, and images are formed upon the retina, as experience demonstrates. However, during the first month, the child gives no sign of being sensible to light; its eyes move but slowly, and in an uncertain manner; it is not even till towards the seventh week that it begins to give proofs of sensibility. A brilliant light only is at first capable of striking and interesting it; it seems pleased with looking at the sun; soon it becomes sensible to the mere light of day. It does not yet, however, distinguish any object; the first which strike it are red; and in general it prefers the strongest colours. At the end of some days, it fixes its attention upon bodies whose colours it can distinguish, but has no idea of distance or size. It stretches forth its hands to seize the most distant objects; and as the first of its wants is to feed itself, it carries to its mouth objects that it seizes, of whatever dimensions. Thus vision is very imperfect at the first period of life; but by practice, and

especially by the conclusions, which the continual errors into which it falls, compel it to draw, its sight becomes perfected really by education.

Infants have been thought to see objects double or reversed; this, however, is clearly erroneous. It is also said, and with more reason, that as the refracting parts of the eye are more abundant, they ought to see objects smaller than they in fact are.

Vision soon acquires all the perfection of which it is susceptible, and in general undergoes no modification till towards the commencement of *old age*. Then it is that the change above mentioned in the humours of the eye tends to render it less distinct; but what renders it still weaker is the diminution of the sensibility of the retina.

Three causes combine to alter vision in the old man; first, the diminution of the quantity of the humours of the eye, a circumstance which, by diminishing the refracting power of the organ, makes the old man no longer able accurately to distinguish near objects. Secondly, the commencing opacity of the crystalline lens, which disorders vision, and tends, by increasing, to produce blindness, causing the disease known under the name of cataract. Thirdly and lastly, the diminution of the sensibility of the retina, or if you please, of the brain, which opposes the perception of impressions produced upon the eye, and leads to complete and incurable blindness.

ON

THE PATHOLOGY AND TREATMENT

OF

DISEASES OF THE EYE.

In treating of the diseases of the eye, I shall follow the same order which I adopted in describing its structure; and proceed to describe, first, the diseases of the facial appendages; secondly, those of its orbitar appendages; thirdly, the inflammation of its membranes, and the consequences of such inflammation, beginning externally and proceeding inwards; fourthly, the various affections of the humours; and lastly, the various accidents to which the eyeball is liable, and certain malignant affections of the eye which render its extirpation necessary.

CHAPTER I.

THE FACIAL APPENDAGES.

SECTION I. CATARRHAL INFLAMMATION OF THE CONJUNCTIVA.

The eyelids are frequently subject to inflammation of a *catarrhal* nature; produced by the same causes that give rise to catarrhal inflammation of other mucous membranes; the attack being seated in the ciliary margins, in the mucous membranes which line them, and in the glandular bodies which form part of their substance.

Symptoms.—The edges of the eyelids are, in the first

place, red, hard, and extremely painful. The mucous surface of the lids is unnaturally red and vascular, and it assumes speedily a thickened and villous character, resembling, when the lids are everted, nearly the appearance of red velvet. The pain is very great, particularly when the lids are moved, for then the inflamed surface rubs against the globe of the eye, and if the membrane covering that is also inflamed, which is not unfrequently the case, the pain is so severe that the patient keeps the lids closed, and carefully avoids all attempts at moving or opening them. On the inside, a feeling of stiffness and dryness is experienced, as if the lids would not move easily over the globe, for the secretion of the mucous membrane is, in the first instance, suppressed; but that uneasiness soon gives way, because the secretion is in fact increased in quantity, and becomes somewhat altered, assuming an opaque whitish yellow appearance, approaching to that of a purulent fluid. The glands which are situated on the external surface of the inflamed membrane, participate in the inflammation, and the secretion from them is either suppressed or altered in its quality, so that the edges of the lids become agglutinated during sleep, occasioning considerable difficulty in opening them when the patient awakes in the morning. Such are the symptoms of the early inflammatory stage.

Treatment.—Antiphlogistic measures are necessary in these cases. Apply leeches to the eyelids, and lotions and mild unctuous remedies to the margins of the lids at night to prevent them from sticking together, resorting also to such internal means as the state of the patient may require.

SECTION 2. PSOROPHTHALMY.

Psorophthalmy is an inflammation particularly of that part of the conjunctiva which lines the lids, but it extends sometimes over the whole of the conjunctiva covering the globe. This complaint is often obstinate, and extremely difficult of cure: it extends over the cornea, conjunctival lining of the palpebræ, the cheek and nose; and, lastly, the globe of the eye becomes affected, if this complaint be not checked. At the origin of this disease, there is a glutinous matter secreted on the edge of the lids; ulcers form: and there is often great difficulty in separating the lids from one another. By this means matter lodges on the lids, and tends to keep up the irritation of the whole of the part. You not unfrequently see the redness extending down the whole of the cheek, and excoriation taking place on the cuticle.

If the inflammation spreads over the whole of the conjunctiva, the lachrymal sac becomes irritated, and effusion of tears over the cheek takes place on the surface of the cheek. The inflammation is of the atonic kind, accompanied with that symptom distinguishing strumous ophthalmia, intolerance of light, and a sensation as if there were some extraneous body in the eye, grit or sand, which gives rise to an effusion of the tears. The lids are very red on the edges, and there is an incrustation of matter on them. There is occasionally a contraction of the integument of the lower lid, by which it becomes depressed and everted. In this inflammation, the secretion deposited from the lids dries up, ulcers form, small briny incrustations are formed, and there is an appearance of

tinea on the lids. The watery part of the secretion from the lids is evaporated, which leaves the incrustations that keep up the irritation and form small ulcers.

In consequence, an alteration in the figure of the tarsi occurs: there is a contraction of the cellular membrane just beneath the lower palpebra, and eversion of that lid. This affection of the eye is of difficult management, and is frequently found in persons of a scrofulous diathesis, in children of large towns who are ill fed and worse clothed, with little attention paid to cleanliness. The complaint is very obstinate in its cure: and if relieved, it generally returns, and becomes as bad as ever. It is not, however, confined to the lower classes, but the higher and middling ranks of society are sometimes attacked with it—those who are of a scrofulous diathesis. In schools also it will be found: it frequently arises from the irritating matter being applied to the lid, which may be conveyed from one to another by using the same towel, or in some such way.

The *treatment* of this complaint does not essentially differ from that of the strumous: it is an inflammation without power, one of the atonic kind. Depletion must not be pursued to any extent. It will be right when any symptoms of irritation are present to remove them by the application of leeches, and opening the bowels. Drastic purgatives must not be exhibited, as they do not answer the object which it is intended to effect: mild aperients, combined with mercurial medicines, such as calomel, the hydrargyrum cum creta, or the blue pill, and in quantities so as to give tone to the system. When any febrile excitement that may have existed is removed, begin with

tonic remedies: that is, when the skin has its natural feel, and the tongue is clean, and the secretions from the bowels are regular in their quantity and quality.

The applications to the part should consist of mild stimulants, and the best form in which they can be exhibited is that of ointment. The briny incrustations on the edges of the lid, and which are secreted from the meibomian follicles, confine the lids so closely together, that in the morning when the patient awakes they have the appearance of being glued together. This leads to produce increased irritation on the edges of the palpebræ. To prevent this, the lids are to be besmeared with some ointment. The one commonly used is that called the citron ointment, the unguentum hydrargyri nitratis: but it cannot be well borne of the usual strength, and therefore is diluted with one-third, or one-half, or perhaps more than this, of unguentum cetacei, and this is applied with a camel-hair brush twice a day, the incrustations of matter being carefully washed off before its application, and then some of the ointment is to be besmeared along the edges. The unguentum hydrargyri nitrico-oxydi is used for the same purpose. In fact, any of the milder stimulating mercurial ointments will do. The application will be required to be varied, and the degree of strength must be regulated by the effect on the eye. The use of the vinum opii will be attended with beneficial results, and the application of blisters will have an universally good effect.

In the use of blisters, however, in this complaint, as well as in strumous ophthalmia, no advantages will be derived from keeping them open; for when this is done,

they are apt to give rise to fresh irritation. Therefore, after the application of a blister, you should desire it to be healed; and, if necessary, direct a fresh one to be applied. By this means the irritation in the eyes will be relieved, and their employment be attended with advantage.

SECTION 3. LIPPITUDO.

In instances where inflammation of the palpebræ has frequently occurred, more particularly in old persons, and those in whom the skin is very thin, — in whom the margins of the palpebræ have become much attenuated and very red, the hair of the palpebræ is lost, so that the edges of the lids have a rawness, which extends to a considerable distance, presenting a very unpleasant appearance; this is particularly the case with respect to the lower lid, the whole external surface of which is sometimes raw and excoriated. This state is called *lippitudo*, and occurs very frequently in old persons, particularly where the eyes have been exposed to smoke or acrid vapours, and where the individual too often excites the mucous membrane of the alimentary canal by unwholesome food. It has two stages; the first is a simple excoriation; the second, an ulceration of the border of the palpebræ. In the chronic form of this affection, in strumous subjects, the conjunctiva is greatly thickened, indurated, and altered in its texture; the ciliary glands are destroyed, together with the fine cuticle of the lid, to some extent beyond the ciliary margin; and a partial eversion of the lids, owing to the tumified state of the conjunctiva, increases the deformity. The mouths of the meibomian glands are obliterated, and the ducts plugged by their inspissated secretion; sometimes the conjunctiva

fungates, so as to render the eversion complete, and a process of cicatrization renders it permanent.

Treatment.—In lippitudo, we must first, if there be any appearance of active inflammation, adopt the means most calculated to remove that; then mild stimulating and astringent remedies applied to the surface of the eyelids, are the most successful. These have the power of bringing the excoriated mucous margin of the eyelids into a better state, and also of exciting a more healthy secretion from the meibomian glands, and will very speedily restore the edges of the palpebræ to their sound and natural condition. The *unguentum hydrargyri nitratis*, or citron ointment, is perhaps the most favourable remedy for this purpose. This may either be employed of its full strength, or diluted with spermaceti cerate. In the surgeon's own hands it is best to employ it undiluted: the milder form alone should be entrusted to others. In applying this remedy, it is necessary first to soften it before the fire and then to apply it by means of a camel-hair pencil to the diseased surface, care being taken that it does not extend to the mucous surface of the eyelids, so as to reach the eye itself. The *red precipitate* ointment may be employed in a similar manner, but it must be only half the pharmacopœial strength. Other forms of ointment have been proposed, but they are all inferior to those just mentioned. The lead and zinc ointment, or one combined with opium, will often agree with those slight, but very irritable lippitudos sometimes met with; but sometimes even cetaceous ointment is disagreeable and affords no relief: in this case hot water is most agreeable and refreshing to the eye, at a temperature which is not endurable to the hand.

In chronic lippitudo, the ducts, which are distended, should be opened, and the white consolidated secretion should be removed, the conjunctiva should be occasionally scarified, and the meibomian borders stimulated by one of those ointments already mentioned. The tarsal edges should also be frequently bathed with an astringent lotion. In obstinate cases, where the conjunctiva is altered in texture, the sulphate of copper carried over the thickened conjunctiva and ulcerated border of the tarsus is very useful; nitrate of silver, sulphate of copper or zinc, or bichloride of mercury in solution applied, with a camel-hair brush, to the tarsal edges previous to the application of the ointment, are also very useful.

SECTION 4. HORDEOLUM.

One of the most common affections of the eyelids is that known by the name of *stye*, or *hordeolum*, from its resemblance to a barley-corn. It consists of a small abscess in the lid, and is produced by an obstruction in the follicles of Meibomius; the secretion from the part is altered, becomes inspissated, lodges on the lid, excites irritation, inflammation, and the process of suppuration; lastly, the small abscess breaks, and matter is discharged. In most instances the suppuration is confined to a small space, but in others it puts on the character of a boil, and sloughing of the cellular membrane then takes place. Some persons are more prone to this disease than others; it frequently appears in those who have been subject to disorder of the digestive organs, or in those of a scrofulous habit of body, and young persons. This morbid affection would be of little consequence in itself, but for

the state of the system on which it generally depends. The eyelids adhere to each other in the morning, which distresses the patient considerably. There may be excoriation of the lids—redness and thickening of the conjunctiva —excoriation of the skin of the face; lippitudinous ulcers break out; the cilia become altered in their growth, and turned inwards on the globe of the eye; and from these different states a tendency to chronic ophthalmia is kept up.

Treatment.

It is necessary when styes are attended with inflammation and redness, that cold applications, poultices, and fomentations should be applied, as in other inflammations; and when matter is formed, that the abscess should be opened with a lancet. But it more frequently happens that this affection depends upon something wrong in the system, on derangement of the digestive organs, or impaired functions in some part of the body; and then these states must be attended to, for they produce irritation, and sometimes ulceration of the edges of the eyelids. The best local applications that can be made use of, are those of a mild stimulating nature, the mercurial ointments, with a little of which the edges of the lid should be besmeared every night at bed-time, the parts being previously washed with tepid water. The citron ointment (the *unguentum hydrargyri nitratis*) is the one in common use; but it is, when of the pharmacopœial strength, too stimulating for the eyes, therefore it must be diluted with some simple ointment. Both the red and white precipitate mercurial ointments are used, and the zinc ointment also;

in fact, it is not essential what kind is employed, if it be mildly stimulating.

SECTION 5. TINEA CILIARIS.

The *tinea ciliaris* is a disease of the ciliary foveola, and hence is commonly combined with lippitudo. It occurs along the inflamed, thickened margins of the eyelids, as small ulcers, not unlike the pustules of porrigo, formed round the orifices of the cilia. The porrigo or crustea lactea overspreading the eyelids and cheeks, with chaps and ulcerations behind the ears, and within the meatus auditorius, are concomitant affections, especially in children.

Treatment.

This affection in its active stage must be combated by suitable antiphlogistic means. When the inflammatory symptoms are gone by, the re-establishment of a healthy conjunctival surface and a healthy meibomian secretion, are the objects to be attempted. Cleanliness is of the first importance, and indeed more depends upon the patient than the surgeon in the cure of these affections. The margins of the lids, and the roots of the ciliæ should be thoroughly cleansed from loose scabs and branny incrustations. Then gently touch the surface, that is ulcerated, with nitrate of silver. Repeat this application once in two or three days, and in the intervals, smear the edges of the eyelids once or twice a day with the citron ointment, previously softened by heat.

SECTION 6. TRICHIASIS.

Another affection to be described is that known by the

name of *trichiasis*. It is that state of the eyelashes, in which they become altered in growth, and turned inwards on the globe of the eye, irritating the conjunctiva on every motion of the eye. Some think that this complaint is not owing to the effect of the altered growth of the cilia only, but to a turning in of the lids, called *entropium*.

SECTION 7. ENTROPIUM.

Entropium, or inversion of the eyelids, is produced from ulceration of the tarsi, the cicatrices formed by the healing of lippitudinous ulcers which alter the shape of the lids, so that the eyelashes are turned inwards, irritate the conjunctiva, and produce a continual state of irritation of the whole organ. There is a watering of the eye, together with chronic ophthalmia, and in a short time vessels may be seen shooting over the cornea; nebula and ulceration of the cornea supervene, and thus a serious state of irritation of the transparent part of the eye is produced.

Treatment.

Where the affection is simple trichiasis, the only means that can be relied on, is to pluck away the eyelashes; some benefit may be derived from applying a piece of adhesive plaster to the lid, which is to be fastened to the cheek, so that the eyelashes may be kept bent outwards. The best forceps for removing the eyelashes is one that is rather broad at the points. But when the lid itself is inverted, nothing will avail, except cutting away a piece of skin from the affected lid; when this is done, the edges of the wound are brought together by strips of adhesive plaster; a cicatrix is formed, and the eyelids are

then drawn upwards. The mode of performing the operation is very simple; lift a portion of the skin of the affected lid with a pair of forceps which have transverse branches at the points, and these grooved transversely; with this lay a firm hold of the portion of the lid, take a pair of curved scissors, and cut off the projecting portion, as near to the edge of the lid as you can.

SECTION 8. ECTROPIUM.

Ectropium, or eversion of the lids, happens from ulceration on their edges, an altered and vitiated secretion from the follicles of Meibomius, which produces a redness and an altered state of the conjunctiva, and from cicatrices and contractions of the skin of the lids, which tend to evert them. This complaint is very distressing to the patient; the eye has not its natural covering; irritation, from extraneous bodies getting into it, is produced, and thus a constant state of chronic ophthalmia is kept up.

Treatment.

When the disease is brought on by a thickened state of the conjunctiva lining the lid, that portion must be removed; if from a cicatrix, it must be divided; but this seldom answers; the divided cicatrix again contracts, and the disease returns. The plan usually adopted consists in removing a triangular portion of the lid, just in the same way as the operation for cancer of the lip is performed; by cutting through a piece of lid which is raised by a pair of forceps, so that the base shall be towards the edge of the lid, and the apex below, at the union of the two sides. A suture is applied through the

incision, the edges of the wound are brought together; these united, tend to keep the lid in the natural position; and, in fact, the operation in this way is often successful.

SECTION 9. PALPEBRAL TUMOURS.

Various small tumours are often to be met with on the lids, such as encysted tumours and others. But as these require no particular plan of treatment different from those in other parts of the body, little need be said about them. In their removal, one thing must be borne in mind, viz., the importance of the organ in the neighbourhood of which they are situated, so that in removing them, no injury is done to so delicate a structure.

SECTION 10. ENCANTHIS.

This consists in an alteration of the structure of the caruncula lachrymalis, and neighbouring semilunar fold of the conjunctiva. The caruncula is enlarged; at the commencement it has a granulated appearance, which it loses as it increases, and then becomes similar to a hazel nut, being ash-coloured, and streaked with varicose vessels. This enlargement or excrescence prevents the lids from closing, and allows extraneous matter to enter, which keeps up inflammation of the eye, and it also presses on the puncta lachrymalia, and turns them out of their place; the tears, thus prevented from getting into the lachrymal sac, are effused on the cheek.

Treatment.

The best treatment is to remove it altogether. It is a simple operation, and is thus performed: an assistant rais-

ing the lid, by taking up the tumour with a pair of forceps, removes it with a pair of curved scissors with convex edges. When this complaint has not assumed the malignant form, it is always remediable by excision. Never operate, however, when the encanthis has become of the malignant kind, and put on the cancerous appearance. This will be known by the dull red colour of the excrescence, its excessive hardness, lancinating pains extending to the eyeball and forehead, particularly when touched; foul ulcers, with irregular edges, having all the appearance of cancer in any other part of the body.

SECTION 11. PTOSIS.

A permanent drooping of the upper eyelid without any inversion of the cilia, or inflammation, occasionally takes place. It is, for the most part, a symptomatic disease, frequently accompanied by some form of paralysis, or consequent on apoplexy. It may either be *congenital*, or dependent on *atony* of the lid generally, or on *paralysis*. The treatment will vary with the cause: if it be *congenital*, or dependent on *atony*, the removal of a portion of the integument by the knife will most probably remove the deformity; but if it depend on paralysis, its removal will then depend on general treatment, which has for its object the relief of the sensorium.

SECTION 12. WOUNDS OF THE EYELIDS.

Wounds of the eyelids are neither dangerous nor difficult of cure; they merely require to be treated by those simple rules which regulate the practice of surgery in other parts. Penetrating wounds of the eyelids, whether horizontal or perpendicular, will, *generally*, require the

insertion of one or more sutures to retain the edges exactly in apposition, assisted by strips of adhesive plaster, a compress, and the due application of a bandage to ensure the perfect immobility of the part. When the lachrymal canal is divided, it is doubtful if union ever takes place in such a manner as to render it pervious. Wounds of the eyelids are very seldom productive of defective vision, or amaurosis, unless some injury has, at the same time, been done to the eye itself.

SECTION 13. FISTULA LACHRYMALIS.

By this term is understood all obstructions of the lachrymal passage preventing the natural flow of the tears and mucus from the eyes to the nose. The most common cause of this complaint is a closure of one of the puncta, and then there is *epiphora*, or a watering of the eye, together with suffusion of the tears, which leads the surgeon to the discovery of the cause. This must be punctured by a small sharp pin, made of gold or silver, which is to be pushed through it to the lachrymal sac; the obstruction is removed and the epiphora relieved.

When the epiphora continues, the eye becomes irritable, a drooping of the lids comes on, and an altered state of the lachrymal sac is produced. The most important source of this complaint is obstruction of the *ductus ad nasum*. The original seat, then, is in the duct leading from the lachrymal sac to the nose, and the tears, instead of finding their way to the nose, flow down the cheek; this symptom may, however, arise from a polypus in the nose, and then it will be relieved by the removal of the polypus. One of the symptoms of malignant fungus of the nose is suffusion of tears from pressure in the nasal

canal; this disease terminates fatally, and if removed it returns; in this complaint the flow of tears is a very unimportant symptom, compared with the original disease which gives rise to it.

But sometimes there is inflammation of the bones of the nose, or periosteum covering them, and the membrane lining the duct, which is thickened, and then the duct becomes more or less obstructed. It not unfrequently takes place in persons of a scrofulous habit, and those who are subject to affections of the covering of the bones. It is also sometimes a consequence of the abuse of mercury.

Fistula lachrymalis may be divided into three stages:—1st. Where there is only simple distension of the lachrymal sac. 2dly. Where there are inflammation and suppuration of the sac. And the third stage is that in which there is a fistulous opening leading from the sac to the cheek.

Simple distension of the lachrymal sac.

The first symptom which leads the patient, in this stage, to observe any thing amiss with the eye, is, that on reading or exposing it to the wind, there is a watering of the eye; in a short time, this becomes constant, and then a swelling appears at the inner corner of the eye, arising from distension of the lachrymal sac, the tears collecting in it. These produce irritation; mucus and purulent matter is secreted; but when the sac protrudes, pressure made on it pushes the tears or mucus either through the puncta, over the face, or down the nose. The complaint sometimes remains in this stage for many years (pressure being occasionally made on the sac to

empty it) with only little inconvenience. From the pressure of the distended sac, and obstruction of the nasal duct continuing, or some accidental cause, irritation is excited, and the second stage produced.

Inflammation and suppuration of the lachrymal sac.

This affection is attended by a puffiness of the inner corner of the eye, redness of the surrounding skin, which becomes swollen and hard, from the effusion of lymph. Suppuration having commenced in the sac, ulceration comes on, and the matter effects an external opening, by which it is discharged. Now obstruction, inflammation, and suppuration do not always take place in the course of the *ductus ad nasum*, from ordinary causes ; but the progress of the complaint, when arising from ordinary and from specific causes will be different. An opening being thus made in the sac, it is rendered permanent, or kept open, by the flow of pus and tears out of the wound, over the cheek ; the disease then arrives at the third stage.

Fistulous opening from the sac to the cheek.

In this stage of the complaint, the patient is distressed a good deal by frequent returns of inflammation and suppuration of the sac.

Treatment.

Although various means have been attempted in the cure of this complaint, no plan has been yet laid down that has proved successful ; or at least the benefit to be derived from the means and treatment recommended is in most cases very slight. In many cases little need be done but to evacuate the sac, for the purpose of pre-

venting irritation in those cases where there is simple distension of the sac. One cause of this complaint is a vitiated state of the follicles of Meibomius: when matter is secreted, and the eyelids are closed together, and irritation is thus produced in the lachrymal sac—in these cases, the lids should be washed with tepid water, and besmeared every night at bed-time, with a little of the unguentum hydrargyri nitratis. By this means, and attending to the constitution, and removing irritation as it arises, the patient may remain in that state for years.

When the obstruction is complete, the distension considerable, the attacks of inflammation frequent, and suppuration has commenced, another kind of treatment must be adopted: in this stage the object of your treatment will be to effect a natural passage for the flow of the tears, that is, through the nasal duct, instead of their flowing over the face. Anel was the first who attempted to procure a passage for the matter and tears into the sac, when the natural one was obstructed; and this he did by introducing a very fine probe through one of the puncta and the lachrymal sac to the *ductus ad nasum*, and thus dilated the stricture; but the instrument was so flexible and thin, that it was ill calculated to overcome the obstruction. Mr. Travers, who has had most extensive opportunities of watching the progress and trying the effect of different treatments in this disease, recommends the use of an instrument of this kind; it is, however, somewhat different; it is more nail-headed, and not of the same exceeding fineness, being more effectual for removing the obstruction. Anel likewise constructed a small syringe, he mouth of which was to be introduced into one of the

puncta, tepid water was then to be injected through the punctum and sac to the nasal duct; but the injection of fluid was found inadequate to overcome the obstruction. It is a useful instrument in gleety discharges from the sac or duct, but beyond this it is quite inefficient.

Mr. Wathen recommended that a hollow metallic tube should be introduced into the *ductus ad nasum;* the object of its being hollow was to allow the passage of tears through it, but it was found inadequate; it soon became filled with mucus. M. Dupuytren was in the habit of using a gold tube in this way, and it is said that most of his cases were cured; this, however, is doubtful. Mr. Pott also advised the use of bougies for removing the obstruction. The plan laid down by Mr. Ware is the one now generally adopted; it consists of introducing a nail-headed style into the *ductus ad nasum*, and letting it remain there. The style should be just large enough to allow of the flow of tears by the side of it. If no opening has been made from the repeated inflammation, the mode to be adopted in making one is as follows: direct the patient to be seated, and then standing behind him, pass your hand round the patient's head, open the lachrymal sac, and then carry a blunt pointed bistoury inwards and downwards and divide the obstruction; the instrument fitted for making the external opening is a phymosis knife. Having done this, ascertain whether the passage is free, and then introduce a nail-headed style about an inch and three-eighths long; the head of the style is to lie obliquely on the front of the cheek, and a piece of adhesive plaster spread on black silk to be put over it, which will prevent persons from suspecting that there is any thing wrong with the eye. The style requires to be removed once a

day for the first week ; and to be washed ; sometimes there is a little irritation produced by its introduction : but in general, there is none, and the comfort the patient experiences is very great ; the water ceases to flow over the cheek—the sight becomes stronger—the tendency to inflammation is obviated ; and, indeed, so much comfort is experienced, that the patient is loth to dispense with the use of the style.

Although the relief obtained from this plan is great, yet no plan of treatment has been decided on which generally proves successful ; for this mode must be considered more in the light of a palliative than a curative remedy ; the obstruction frequently returning when the style is removed. It sometimes happens that from disease about the bones of the nose, a fistulous opening from the sac to the nose is formed. If an operation should be determined on in such a case, a sharp pointed instrument must be introduced, either a probe or trocar, through the fore part of the os unguis into the nose, and the only point which remains is to keep open the perforation by a sponge tent, or nail-headed style ; but it becomes rarely necessary to perform this operation.

CHAPTER II.

DISEASES OF THE ORBITAR APPENDAGES.

SECTION I. ABSCESS.

Abscess sometimes forms within the orbit, and previous to its discharge occasions an equal protrusion of the globe,

with eversion of the eyelid, dilated pupil, and suspended vision. Its situation and effect upon the eye give much pain and apprehension to the patient, as well as considerable disturbance to the system at large. The sight is sometimes permanently extinguished. In other cases it returns after the discharge of the abscess, and consequent removal of pressure. If the formation of matter cannot be prevented, the free discharge of it should be assisted by keeping the external orifice freely open, until the sac has gradually contracted and closed. If the abscess should have formed in the cellular texture and parts surrounding and supporting the eyeball, the cure will be effected without any deformity; but if it should be connected with the periosteum lining the orbit, it will frequently be found to give rise to very troublesome consequences, and often to deformity by causing an eversion of the lid affected by the disease.

SECTION 2. FATTY AND ENCYSTED TUMOURS.

Tumours of various kinds occasionally form in the orbit. Some are compact, and consist of fatty matter; others contain a mixture of liquid and cretaceous matter, or a limpid and sanious fluid. When they project above, below, or to one side of the eye, they may be removed, by dividing the conjunctiva immediately over the tumour, then seizing the tumour with a double hook, dissect it out.

When the tumour is hard, or of an anomalous character, it generally arises deeper in the orbit, and, in advancing to the surface, displaces the eye so as to cause considerable deformity, and frequently to destroy vision.

When the tumour is posterior to the eyeball, or connected with it, it can scarcely ever be removed, unless the eye be extirpated at the same time,—generally the most advisable step, as the eye will, in most cases, be either useless or disorganized. Tumours sometimes form beneath the periosteum of the orbit, giving to the touch a firm resistance: such cases are always unfavourable, seldom curable.

Polypi of the frontal, sphenoid, and ethmoid sinuses, in their progress burst through the ethmoid and lachrymal bones, and sometimes extrude the eyes, so as to occasion the most horrible deformity: in such cases, an operation offers the only, though doubtful, remedy. Exostoses of the orbit rarely occur.

SECTION 3. ANEURISM IN THE ORBIT.

The looseness of the connecting texture in the orbit, and the number and tortuosity of the vessels, seem to predispose to that disease of the arterial and venal extremities, which gives origin to peculiar vasculo-cellular tumours, the precise nature of which is not yet satisfactorily ascertained; combining, as they do, the structure of nævus, with the more formidable character of aneurism. Two cases of this disease are recorded, in both of which the carotid artery was tied with complete success.

SECTION 4. EXOPHTHALMOS.

A protrusion of the eyeball not only accompanies tumours, when of a large size, but takes place from other causes. The simplest form is, when the protrusion takes place in consequence of inflammation, which on subsid-

ing, has left an induration of the cellular texture behind, or around the eye, causing it to project: in such cases, it may generally be removed by alteratives, by the establishment of a drain in the neighbourhood, by attention to the state of the bowels, and by good air and exercise. If the swelling should degenerate into a scirrhous tumour, extirpation of the whole contents of the orbit offers the only, although doubtful, chance of recovery. Schmidt relates the history of two cases of exophthalmos from an hydatid of the lachrymal gland.

SECTION 5. DISEASE OF THE LACHRYMAL GLAND.

The lachrymal gland is subject to simple or interstitial enlargement, to suppuration, and to scirrhus, like other glands of similar structure. Its enlargement is known by the lobulated appearance of the tumour, on further stretching the skin of the projected lid. It often suppurates in children, and occasions an excessive swelling above the upper eyelid, depressing the tarsus upon the globe so as completely to conceal it. The abscess may be conveniently opened and discharged beneath the lid, with a narrow curved bistoury. Mr. Travers removed this gland, in a state of true scirrhus, from the orbit of a middle aged man, with success. There was no other deformity than a slight drooping of the lid at the outer angle.

CHAPTER III.

INFLAMMATION OF THE CONJUNCTIVA.

SECTION I. SIMPLE INFLAMMATION OF THE CONJUNCTIVA.

THIS may be divided, like other inflammations, into acute and chronic. The symptoms of inflammation of the conjunctiva do not differ from those of inflammation of other parts of the body, except in so far as they are modified by the structure of the part, and by the function of the organ. Indeed the change which takes place in inflammation of the conjunctiva may be regarded as a very beautiful instance and illustration of the change which takes place by the process of inflammation in general.

Inflammation of this organ may exist in various degrees, from the slightest degree of excitement up to inflammation of the most violent and intense character.

The first symptom is redness of the part: which is very remarkable, because the blood naturally conveyed by the vessels to this part is colourless. Under any existing irritation, the vessels are distinctly observable, and become injected by red blood. When the irritation continues, the vessels become still more apparent, and at length all the interlacements and anastomoses of the vessels of the conjunctiva partake of the inflammation, and present almost one uniform appearance of redness. During this time more or less pain is experienced; at first, as the vessels become filled, an uneasy sensation is felt; this increases, and at length, upon the admission of light, a sharp lancinating pain is experienced; the patient

is under the necessity of keeping the eye closed, and, indeed, has some difficulty in raising it, not only from the pain he suffers, but from the degree of fulness and swelling with which it is accompanied. This pain goes on increasing, and at length the patient complains of a burning heat, and a sensation as if some extraneous body were lodged in the conjunctiva: a sort of grating between the conjunctiva and the lid. At this time the admission of the least light or air produces such lancinating pain, that the eye is spasmodically closed. During the first part of the inflammation there is a more abundant secretion of tears, and this generally increases, until there is a constant flow of water from under the lids.

It sometimes happens that, at the highest stage of excitement, this increased secretion is suddenly diminished, and there is a preternatural dryness of the eyes, producing painful sensations. A considerable degree of swelling takes place; the conjunctiva becomes turgid from the increased quantity of blood admitted by the vessels, and effusion follows. Although the swelling is pretty equally diffused over the whole surface of the conjunctiva, it seems to be the greatest at the transparent cornea, because here the membrane is more firmly adherent. The conjunctiva is here elevated in a circular fold, and this appearance is called chemosis. The eyelids are in general more or less swollen from the same cause; namely, the greater determination of blood to the part, and the filling of the vessels. Not only is pain experienced in the eye, but also a sense of weight and fulness in the globe of the eye, as if the ball were too large for the socket. The neighbouring parts also, the forehead and temples, par-

take of the pain; there will be a shooting pain in the maxillary bone, or more deeply seated in the head; these pains are in some instances extremely violent. This train of symptoms is attended with a greater or less degree of constitutional irritation. The patient complains of great lassitude, prostration of strength, chilliness, or rigor followed by heats. His skin will often be hot and dry, and his pulse quick and hard; his stomach will be affected, and nausea or vomiting produced; he will often complain of pain in the back, and in short of all the symptoms which indicate a considerable fever of the sympathetic kind, arising from local irritation.

The degree in which these symptoms occur will of course vary according to the constitution of the patient. In young and robust persons there will often be a high degree of local inflammation, without much constitutional irritation; while, on the other hand, in delicate and irritable patients, a much less, nay sometimes a very trifling degree of local inflammation will be accompanied with violent symptoms of constitutional derangement. Accordingly, although, *cæteris paribus*, the degree of constitutional irritation will be proportional to the degree of local excitement, this principle will be so much modified by the particular constitution of the patient, that in cases where, from the violence of the inflammation, much constitutional derangement might be expected, very little will occur; and *vice versa*, where, from the slight degree of local excitement, very little might be expected, it will sometimes happen that a great degree of constitutional irritation will attend it.

So much for the symptoms of ophthalmia, as existing

in simple inflammation of the conjunctiva, without any particular modification. It will not be necessary to point out particularly the predisposing causes of this complaint, because they do not differ from the predisposing causes of inflammation in any other part of the body. It is only necessary, therefore, to point out some of the causes which most frequently produce irritation in the eye, and lead to inflammation of the conjunctiva. Any extraneous body lodging in the conjunctiva will produce this effect; and this is so frequently the cause of inflammation, that it will be right in all cases carefully to examine its surface in order to ascertain whether there is any extraneous body in it, such as a particle of dust or sand, a piece of grit or lime, or any of the scoriæ which often fly off from iron while it is beaten on the anvil. Any extraneous body of this kind will readily produce irritation, and inflammation of the conjunctiva.

Variation of temperature, especially when accompanied with any sudden access of light, will produce this inflammation. Thus it has often happened that persons who have gone out of a warm room to look at fire-works have been attacked with it. The change of temperature, together with the brilliant light to which the eye is exposed, seem to produce it. Persons sitting in a hot room, or a theatre where there is much light, and exposed at the same time to a draught of cold air, have often had inflammation of the conjunctiva. So, particular states of the atmosphere will become in some degree excitants of this inflammation, and it has been observed to be more frequent during the prevalence of easterly winds. There seems to be some ground for this opinion. Other causes

of this inflammation may exist, but it is not necessary to enumerate them more at large. The principal causes are, the admission of any extraneous body and variations of temperature, especially if accompanied by intense heat and light, or partial exposure to draughts of cold air.

The chronic stage.

The term *chronic* is not, as its etymology would indicate, applied merely with reference to duration of time; it is not only applied to signify that state of congestion and debility of vascular action produced by the acute stage, but it is also applied to that state of inflammation which from the commencement has a character of atony and debility. As this is the more frequent form in which this inflammation occurs, whether primary or following the acute stage, it is necessary to attend particularly to the symptoms by which it is distinguished, as the mode of treatment is very different from that which is required in acute inflammation.

The symptoms of chronic differ from those of acute inflammation of the conjunctiva rather in degree than in kind; so that after they have existed for some time in the acute stage, the disease gradually passes into the chronic stage. The redness will be less intense, the pain which accompanied it less acute, the intolerance of light will be less, the chemosis and swelling will be diminished, the effusion of tears less considerable, the constitutional irritation will in a great degree have subsided, and, in short, all the acute symptoms will be much mitigated. There will still, however, remain a considerable degree of irritability in the eye on exposure to light; some ar-

tificial defence to exclude the light will be necessary, and the person will still be incapable of applying the organ to the ordinary purposes of vision.

The causes of chronic inflammation, both exciting and predisposing, are very similar to those of acute inflammation, and indeed one form very commonly passes into the other; but, at the same time, it is to be remembered that there are many causes which tend to produce this inflammation, accompanied with atony and debility in the very outset, which distinguish it from acute ophthalmia. Chronic inflammation of the conjunctiva is very apt to take place, where the patient has for a long time been labouring under disorder of the digestive organs. Patients who have this form of the inflammation often complain of dyspeptic symptoms; such as uneasiness about the scrobiculus cordis; distension of the stomach after eating, flatulence, disagreeable tastes in the mouth, bitter, sour, or putrid; furred tongue, and other symptoms indicating derangement of the digestive organs. Inflammation of this kind is very apt to arise from, or to be kept up by, exposure to acrid fumes or smoke in particular trades. It is not unfrequently the concomitant of dentition, the measles, or small pox; it sometimes accompanies rheumatism and gout. Frequent intoxication and various other causes may predispose to it, which it will be necessary to investigate carefully, because the mode of treatment will materially depend upon them.

In general, inflammation of the conjunctiva is a very manageable complaint. It passes into chronic inflammation after the acute stage has continued for a certain time, and it not unfrequently subsides of itself. A spontaneous

cure, however, is by no means to be depended upon, and we ought on no account to neglect or relax in the proper mode of treatment, from any reliance upon such a cure; because simple inflammation of this membrane may lead to inflammation of the deeper-seated tunics of the globe of the eye; suppuration may be induced, the organ may at length become permanently disorganized, and the sight of the eye irretrievably lost. The consequences of inflammation of this membrane are very similar to those of inflammation in other parts of the body. It sometimes terminates in effusion, the serum or blood under the conjunctiva rising in a roll above the transparent cornea. It sometimes produces the adhesive process; and when it terminates in this manner, the adhesive matter is deposited under the conjunctiva, which covers the transparent cornea, and is recognized by a hazy appearance at the part. The adhesion is various, both in its extent and quantity; it is sometimes so slight as only to produce a simple clouded appearance over a certain part of the cornea, which is technically called *nebula;* it is at other times more considerable in quantity, and produces an appearance of considerable opacity in the cornea, which is usually called *albugo*, or *leucoma*. The deposit of matter is sometimes confined to a simple speck, and is sometimes spread more or less over the whole surface of the cornea, so as to interrupt or intercept vision altogether.

The inflammation sometimes proceeds to the suppurative process; indeed, the tunica conjunctiva appears to be of a nature very analogous to the mucous membranes of the body, and like these, is exceedingly prone to the suppurative stage of inflammation. The suppuration gene-

rally proceeds from the surface of the conjunctiva, as from the surface of any mucous membrane in a state of inflammation. In other instances, the formation of pus is circumscribed; a deposit of lymph takes place where the conjunctiva covers the cornea, or in its immediate vicinity, and a little abscess or pustule arises from the centre. Ulceration is also sometimes produced: this usually occurs in the cornea, in consequence of laying open this pustule, probably from the denudation or exposure of the cornea. Lastly, sloughing and mortification of the cornea is not an uncommon effect of a high degree of suppurative inflammation. The same consequences, therefore, occasionally arise from inflammation of the conjunctiva as from inflammation in other parts of the body; namely, effusion, adhesion, suppuration, ulceration, and mortification.

Of the treatment of simple inflammation of the conjunctiva.

It will be necessary to adopt at once, with vigour, the antiphlogistic plan of treatment. As the best mode of diminishing the action of the heart and arteries, the use of the lancet should be freely resorted to, in the commencement of inflammation of the conjunctiva. It will not do, only to take away a certain quantity of blood; as, for instance, eight, ten, or sixteen ounces; but in this, as in all other cases of acute inflammation, accompanied with hardness of the pulse, it is necessary to make a free orifice in a large vein, and take away a quantity of blood, until some manifest effect is produced upon the action of the heart and arteries; ascertain how the heart is af-

fected, and carry on the bleeding even to faintness. This may prevent the necessity of again having recourse to the lancet; or if it should be necessary to do so, blood may be taken away in much smaller quantities. The patient's pulse is the only certain criterion; and when this is diminished, leeches may be afterwards conveniently applied.

The application of leeches, in the first instance, except in large numbers, is seldom sufficient in acute inflammation; three or four leeches will scarcely produce any effect upon it. Opening the temporal artery is another mode of bleeding, which is attended with very good effects in this inflammation. This practice has been decried by some persons, who suppose that by opening the temporal artery you force the blood to pass through the anastomosing branches, and in this way throw more blood into those vessels which are immediately distributed to the eye. Whether this be the case is not quite clear, but certainly good effects have been observed from opening the temporal artery in this inflammation, and therefore it may sometimes be proper to adopt this practice. Some practitioners recommend the practice of dividing the vessels of the part by scarifying the conjunctiva. This is a practice, however, which is not to be recommended; the quantity of blood taken in this way is small; the irritation produced in performing the operation is considerable, and the clots of blood left after it often excite or keep up inflammation of the conjunctiva.

Great benefit is derived from treatment directed more especially to the body at large; such, for instance, as diaphoretic medicines. The tartrate of antimony is a very

useful medicine of this kind; perhaps there is no medicine which, after blood-letting, tends so effectually to keep down the action of the heart and arteries. It should be given in such doses, and repeated at such intervals, as to keep up a state of nausea. Purgative medicines are thought by some persons to be not at all necessary in this inflammation. Richter, a very valuable writer on surgery, is of this opinion; which is rather extraordinary, for much benefit will undoubtedly arise from evacuating the bowels of any accumulation of feculent matter. Constitutional irritation will be materially abated by keeping up the secretions from the intestines, and in many cases, by altering and rendering them more healthy. The bowels should therefore be freely acted upon by doses of calomel, combined with jalap, scammony, or cathartic extract; and the effects of these medicines should be kept up by the exhibition of neutral salts, so as to produce a considerable number of watery stools. At the same time, the diet of the patient should be low, and he should be kept in a state of perfect rest and quietude.

When an impression has been made in this way on the symptoms, it will then be proper to adopt other plans of treatment; for instance, when blood has been taken to a considerable extent, the application of a blister to the nape of the neck will be attended with beneficial effects. The treatment of the part is also to be considered; the head should be kept raised, so as to favour the return of the blood from the eyes, and the access of air or light should also be prevented by keeping the room darkened. It is not to be inferred from this, that the room should

not be kept well ventilated, for this is a very material point, but only that the patient should not be exposed to variations of temperature. With respect to local applications, it will in general be found that moist warmth is most agreeable to the patient in acute inflammation of the conjunctiva. This may be applied in the way of fomentations, either by means of tepid water, or decoctions of marsh-mallows, poppy-heads, or camomile flowers. Where there is much irritability, steam will often be found useful, and especially the steam of water in which opium has been infused, from which the patient will experience great relief.

Some persons recommend a sort of poultice, although from the tumefaction of the lids, this is an application which cannot be very conveniently used. The poultice, of course, is not of the ordinary description; it is generally made of camomile flowers, boiled so as to be rendered extremely soft, and put into a gauze or muslin bag, which should be applied so as to make a very slight degree of pressure on the eye. If poultices are employed, they should be very frequently changed, for otherwise they are very apt to confine the secretions, and rather to keep up than diminish irritation. Fomentations, however, are greatly preferable.

Many persons prefer cold to warm applications; if cold applications are employed, care must be taken that they do not stimulate the part. The choice of cold or warm applications should depend entirely on the feelings of the patient; if he do not find relief from warm, you should then try the effect of cold applications. In general, moist warmth has, however, a tendency to produce

relaxation of the vessels, and to favour the passing of the acute into the chronic stage of inflammation.

Warm applications must not be continued when the chronic stage has commenced, for they would then do mischief instead of good. On this account, it is necessary to observe attentively the change of the inflammation from the acute to the chronic stage, that the plan of treatment may be altered as soon as the latter stage has commenced.

In the *chronic stage* the evacuating plan may, to a considerable extent, be laid aside; the diet, though still not stimulating, may be more generous; there will be no necessity for continuing diaphoretic medicines, as the skin will generally be sufficiently moist, nor will it be necessary to evacuate the bowels so freely, though attention should be paid to their due action; alterative medicines will often be found beneficial. The local applications should be of an entirely different character; they ought to be moderately astringent and stimulating, as your object now is to excite some degree of action in the vessels, and to get rid of their relaxation and atony, care being taken at the same time not to stimulate the parts too much.

Various collyria or eye-waters are used for this purpose; all of them moderately astringent or stimulating; such as the solution of alum in water, solutions of the sulphate of zinc, or the sulphate of copper, or the liquor plumbi subacetatis. These solutions should at first be very much diluted; ten drops of the liquor plumbi subacetatis may be added to four or six ounces of water; a grain of alum, or half a grain of the sulphate of zinc or

copper, may be dissolved in an ounce of water. The solution should be gradually strengthened, in proportion to its action on the part and the degree of stimulus which may be required. To judge how far the stimulus may be carried, the criterion is exceedingly simple; if a certain degree of smarting and pain is produced, which soon subsides, and leaves the patient much more easy than before, the collyrium is beneficial; if, on the other hand, the patient experiences a great degree of pain, which does not subside speedily, and the vessels become turgid, the collyrium is doing harm, and the quantity of stimulus ought to be diminished.

The best mode of applying an eye-wash of this kind is to inject it by means of a silver or ivory syringe, introduced under the lids every two or three hours. In this way, the solution is more surely diffused over the whole surface of the conjunctiva. An eye-cup will answer the purpose very well, if the patient, after immersing his eye in the cup, has the courage to open it. The syringe, however, is a more manageable instrument. Mr. Ware recommended, in chronic ophthalmia, what in the old pharmacopœias used to be called tinctura thebaica. The vinum opii will answer the same purpose, and seems to be one of the best stimula which can be employed in chronic ophthalmia; it acts as a mild astringent, and at the same time, by its soothing quality, sheathes the effect of the stimulus, so that no pain is produced. Patients are able to bear them stronger when the chill is taken off from them; the warmth of the application seems to take away the pain, while the effect remains the same. The vinum opii may be employed in the quantity

of one drop, or even of two or three drops, two, three, or four times a day. It will be best to drop it into the inner canthus of the eye, with a camel-hair pencil; the patient should then shut his eye, and move it about, so that the fluid may be diffused over the whole surface. Mr. Green has seen this application used two or three times a day, and in the case of children, sometimes only once a day, with the most decided benefit. There is another circumstance which should be attended to in the treatment of chronic ophthalmia, namely, not to exclude the light so much as in acute ophthalmia. If the patient can bear a moderate degree of light, it should be freely admitted. He should wear no bandages, and have no other protection than a shade. Continued darkness and heat are very apt to keep up a morbid state of sensibility and irritability in the eyes. Lastly, with respect to the treatment of chronic ophthalmia, the various causes which predispose to, in some instances excite, and in many keep up, this state of the complaint. Conjointly, therefore, with those remedies which have just been pointed out, others must be given to act on the morbid state of the constitution which keeps up the local irritation, and success in the treatment of this inflammation will very materially depend on the accuracy with which the causes have been investigated, and the judgment with which the remedies are applied.

SECTION 2. PURULENT OPHTHALMIA.

Suppurative inflammation of the conjunctiva is the most severe form of inflammation in that membrane. It is exceedingly acute, very rapid in its progress, and often

very destructive in its ultimate effects. This form of the complaint requires very active treatment. The symptoms are so manifest that there can be no doubt of the nature of the complaint, its prominent character being the formation of a considerable quantity of purulent matter. In other respects, the symptoms are not very different from those which characterize inflammation generally. The patient at first feels an uneasy sensation about the eyes; next some degree of pain on the admission of light, which increases to a considerable intolerance of light. Redness of the vessels is observed, and besides this, a greater degree of swelling than commonly attends simple inflammation. The eyelids soon become much swollen, the conjunctiva, where it covers the fore part of the globe of the eye, is tumid; there is considerable chemosis, and often such turgescence of the upper lid as to prevent the patient from raising it. The lids are often so much tumefied as to become everted, so that a sort of roll of the lid is formed. These are the symptoms which precede the discharge of matter.

A fluid first appears which is not opaque, and has the character of tenacious mucus; in the course of twenty-four hours it assumes the appearance of pus. It is thick, yellow, sometimes green, and poured out in considerable quantity. The appearance of the tunica conjunctiva has been not inaptly compared to the fœtal stomach, when injected. It has the appearance of a villous membrane highly injected with red blood, and certainly very nearly resembles the internal surface of the fœtal stomach when highly injected. If examined with a glass, drops of pus

may be observed oozing on the surface, and collecting there in considerable quantities.

The acute stage of purulent ophthalmia is of very short duration; it has a tendency to pass rapidly into the atonic stage, in which there is action without power, and congestion of the vessels of the part. At this time the violence of the acute symptoms is mitigated, but the patient labours under considerable prostration of strength.

Purulent ophthalmia has a great tendency also to terminate in sloughing. The cause of this tendency it is perhaps not very easy completely to explain; Mr. Travers thinks that it is produced by a constriction of the small vessels distributed to the part of the cornea, in the same way as sloughing of the glands is produced in paraphymosis by the cutting off of such vessels. Sometimes the sloughing commences in a small portion, and gradually lamella after lamella is destroyed, until the aperture assumes a funnel-like shape; at other times a slough forms in a considerable portion of the cornea at once, and opens into the anterior chamber. The commencement of the sloughing process may be recognized by a haziness of the cornea, which soon amounts to considerable opacity. When a dark appearance is observed beyond the ulcerating parts running from the deposit of lymph, so as to form a surface from which the chasm is to be filled up, this may be regarded as a favourable sign that the sloughing has here found its limit. The case is not to be regarded as hopeless when sloughing of the cornea has commenced, for if the opening be only small,

the common effect is that the aqueous humour will escape ; the iris will become prolapsed into the aperture of the cornea, but the patient may afterwards recover, and though the shape of the pupil will be altered, he may still retain a considerable degree of vision. When the opening is large, the iris will not only be prolapsed, but protruded ; not only the aqueous, but the crystalline, and the vitreous humours will escape, and the sight of the patient will be irretrievably lost.

The causes of purulent ophthalmia are various ; it is often occasioned by the violent degree of inflammation produced by some highly irritating substance, such as caustic lime. It occurs occasionally in new-born children ; in this case it is doubtful whether it arises from the first exposure of the eye to the light, or, as is commonly supposed, from the application of the vaginal secretions to the eyes of the child on its passage into the world. It generally takes place in the first week or month after the birth of the child, and seldom later than three months.

Gonorrhœal ophthalmia.

One of the most violent forms of purulent ophthalmia, is that which is called gonorrhœal, from its being produced by the application of gonorrhœal matter to the conjunctiva. This of all others produces the most intense degree of inflammation. It may be readily traced to the cause just stated, in consequence of the person labouring under this disease inadvertently using a towel, or any thing to which the gonorrhœal matter has been applied, and thus conveying it to the part. This inflammation has been stated, upon what may be considered

good authority, to be a metastasis of the gonorrhœal symptoms from the urethra to the conjunctiva. Mr. Green has never, however, seen a case in which he could entertain the least suspicion that the complaint was produced in that way, and he does not think that there is sufficient evidence to establish such an opinion.

Epidemic ophthalmia.

There is another form of ophthalmia, which has been called the epidemic, or Egyptian; epidemic, in consequence of its attacking a number of persons at the same time in particular districts; and Egyptian, because it resembles that form of ophthalmia with which our troops were attacked in Egypt in the year 1801. This disease was, however, well known in this and other countries long before our soldiers went to Egypt; and it has taken place in districts where there could be no possibility of communication with those soldiers. There can be no doubt that it arises spontaneously, and often attacks epidemically a number of persons in the same district. How it arises it is difficult to say; it was supposed to be produced in Egypt by the combined effects of heat and dust; but it is doubtful whether it may not rather arise from some particular state of the atmosphere with which we are not perfectly acquainted.

Treatment of purulent ophthalmia.

If the lancet is to be used in any kind of ophthalmia, it is more especially to be used, not only boldly, but very early in this. It may be said, indeed, that unless some decided impression is made on the symptoms in the first

twenty-four hours, we shall be unable afterwards to check the progress of the disease. It will be necessary, therefore, to push blood-letting to a very considerable extent, in an early stage of this inflammation. Topical bleeding, by the application of leeches, is quite out of the question in this complaint, except in the case of children. Blood should be taken in large quantities from the arm of the patient. The army surgeons, who have had the most extensive opportunities of witnessing this form of the disease, all concur in the utility of copious bleeding.

All the antiphlogistic remedies which have been before enumerated, are to be put in practice in this case. Purgatives should be administered so as to produce a considerable quantity of watery stools; diaphoretic medicines, and especially the tartrate of antimony, in doses of a quarter or half a grain, should be given at such intervals as to keep the patient in a state of nausea, and topical applications should be employed very much in the same manner as in simple inflammation. During the first stage of the complaint, moist warmth in the form of fomentations and poultices will be found beneficial. The acute stage, however, is of very short duration, and they are not to be continued beyond that period.

The extent to which the antiphlogistic plan should be pushed must vary, according to the violence of the complaint and the constitution of the patient. Young, robust, and plethoric patients will bear depletion to almost any extent; on the other hand, more caution must be exercised where the patient is of a weakly, debilitated, or irritable habit of body. Nothing must, however, deter from the adoption of an active plan of treatment, until

a manifest effect has been produced on the system of the patient: until the pulse becomes soft; the skin moist; the pain, swelling, tension, and throbbing of the eyes considerably abated; the chemosis diminished, and in fact all the acute symptoms more or less subdued. When this is the case, if attended to in an early stage, the subsequent treatment will in general be very easy.

It often happens however, that the surgeon is not called to this complaint until it has arrived at the chronic stage, when the conjunctiva is feebly pouring out pus, the pulse depressed, the skin cold and clammy, the countenance sallow, and when the constitution has materially suffered from the progress of the disease. In this state, an entirely different plan of treatment will be required. Gently stimulating applications should be employed by means of a syringe, so as to cleanse the conjunctiva, and free it from the pus which has collected on its surface, and at the same time stimulate the relaxed vessels. In general it will be necessary to employ tonic remedies, such as bark, for instance, always attending to the due action of the bowels, without which tonics would be useless, and even injurious to the patient. To children, bark may be given in the form of extract, to the extent of from two to five grains, two or three times a day. The eyes should not be bandaged, nor should the matter be allowed to collect; cleanliness is of great importance in the treatment of this form of the disease.

With respect to the treatment of the sloughing cornea, some nicety will be required. When it is ascertained that the sloughing process is commencing, from the hazy or opaque appearance of the cornea, the antiphlogistic

must be changed for a gently stimulating and tonic plan of treatment. Weak astringent collyria should be used to favour the throwing off of the sloughs. The solution of alum, of the nitrate of silver, and the undiluted liquor plumbi acetatis are the best. Observe the process of the sloughing from time to time: if there is a firm layer beneath, the patient is going on well, but if the sloughing has a flocculent, soft, ash-coloured appearance, in addition to mild stimulants to the part, tonic remedies, such as bark, ought to be employed.

In the treatment of purulent ophthalmia, it is of great consequence to pay strict attention to the changes which take place in the symptoms, so that neither the depleting nor the tonic plan may be blindly continued. The treatment should be regulated by the violence of the symptoms, and by the changes which take place as the disease passes from the acute to the chronic form. The errors in the treatment of this complaint may be comprised in two words; they consist either in continuing the depleting plan too long, or in not resorting to it sufficiently early. If the antiphlogistic plan be not adopted at a very early stage of the disease, the tonic treatment will afterwards be of no service; and, on the other hand, if the depleting plan be continued too long, the restorative process, and those beneficial effects, which nature would otherwise assist in producing, will be checked.

SECTION 3. STRUMOUS OPHTHALMIA.

Strumous, or scrofulous ophthalmia, is so called, because it is met with in those persons who are of a scrofulous diathesis—it occurs in children, and not unfrequently in

adults. This inflammation is of the atonic character, that is, it is chronic from the commencement, it is one of atony from the beginning; and the reason why it is necessary to speak particularly of this complaint is, because there is one symptom invariably present,—intolerance of light. The patient cannot bear the least access of light; there is great difficulty of opening the lids, the orbicularis palpebrarum appears spasmodically contracted, and so difficult is it for a patient to open the eyes, that he can seldom do it: an adult may have sufficient resolution, but it is necessary that the eyes should be opened. The only way in which this can be done, is by fixing the head of the patient, when it is a child, between your knees, with the forefinger of the one hand to raise the upper lid, and that of the other to depress the lower, which will give you an opportunity of seeing the eye; but in doing this, great caution will be required to prevent eversion of the under lid, or any undue violence to the part. When the conjunctiva is examined, it is surprising to find how little it is inflamed, though the child does not raise its head from the mother's lap. It will be necessary to examine the eye frequently during this state.

Disorganization of the different parts of this organ often take place; the cornea, or rather conjunctiva covering it, becomes covered with an opaque capsule, with vessels shooting over the cornea, so as to give it an herpetic appearance; that is, there will be seen over the cornea yellow spots, which are deposits of lymph. These open into small ulcers, which are streaked with vessels carrying red blood. The eye becomes very painful, and extremely irritable, and there is often, in this state, in-

tense redness of the conjunctiva. Under these circumstances, similar ulcers form in different parts of the cornea. The formation of these ulcers produces all the symptoms of acute inflammation of the eye, and the organ not unfrequently becomes slowly and gradually disorganized. So long, however, as the cornea continues bright, and of its natural colour, there will be no danger to be apprehended from the formation of ulcers. But it is of the greatest importance that the cornea should be narrowly watched, as, if the inflammation continues for a long time, ulcers are very apt to form on it. But the most distressing symptom, and the one about which the patient expresses the greatest uneasiness, is the intolerance of light.

Treatment of strumous ophthalmia.

Although this inflammation is one of the atonic kind, yet there exists considerable irritation. Depletion must be had recourse to, but not to any considerable extent; it will be right to apply leeches, but certainly blood-letting should not be pushed too far, and throughout the whole treatment it will be necessary to keep in view the nature of the constitution which is generally met with in scrofulous subjects; it is languid and debilitated; the digestive organs are deranged; there is loss of appetite—tongue white and furred; bowels torpid; secretions defective in quantity and in quality—skin dry and hot; in fact there is a good deal of fever present.

The mild depleting plan must be first adopted, regulated as far as the constitution will bear it: remove the symptoms of irritation; open the bowels freely by calomel purges, repeated more or less frequently as they improve

the secretions. Alterative mercurial medicines should then be given; and, if necessary, they should be combined with rhubarb and magnesia, but not so as to produce watery stools.

When the fever becomes diminished, the bowels perform their natural functions, the tongue looks clean, and the skin assumes its healthy feel, then begin with tonic remedies. Aromatic bitters, combined with alkalies, will be found useful remedies. But, at the same time, the state of the constitution must be amended by attention to regimen and diet. The food should be light and nutritious, clothing warm. Exercise should likewise be taken; not to such an extent as to produce febrile excitements, but to invigorate the health.

Sea-bathing will be of advantage; and when the constitution is not in that state to bear the cold-bath, the warm should be used; and if the patient is in a situation where sea-bathing cannot be resorted to, he should sponge himself with tepid water, gradually accustoming himself to the use of cold; by this means the general health will be much improved.

As for the treatment of the part affected, it will be right to employ depletion at the onset, as far as the application of leeches. It will be proper also to apply blisters behind the ears, or to the nape of the neck; and in this complaint they are no ordinary remedy. After the application of a blister, it is surprising how soon the intolerance of light will vanish, even in children; their disposition will rapidly alter, and the inflammation be so slight, that the eyes may be opened without any trouble. Warm and moist applications are beneficial; the steam

of water containing opium allowed to go on the eyes will be good. About a drachm of opium dissolved in a pint of hot water, and the steam of it directed over the eye, will relieve, to a considerable degree, the irritation.

But if any of these applications be used at the onset, they must not be long continued before recourse is had to mild astringent collyria. Their strength must be regulated by the feelings of the patient; not so strong as to irritate, but to be followed by relief to the part affected. The vinum opii is a remedy particularly adapted to this complaint, at an advanced stage: it tends considerably to lessen the irritability of the part, and to increase the strength of the relaxed vessels. At the onset, however, a more active plan of treatment must be adopted: relief must be sought by the application of leeches and blisters, more especially by the last. It will be necessary sometimes to give mercury so as slightly to affect the mouth, remembering the state of the constitution in scrofulous persons, and taking great care that it is not pushed so far as to affect the general health.

The consequences of inflammation of the eye requiring distinct notice, and which are accompanied with equal or less inflammation of the conjunctiva, and kept up or excited by attendant circumstances, are now to be spoken of. In the first place, we shall treat of

SECTION 4. NEBULA.

This complaint is so called from the nebulous or cloudy appearance of the transparent part of the eye, which is produced by deposits of lymph into the conjunctiva covering the cornea. The membrane or layer stretched

over the cornea will vary according to the more or less relaxed state of the vessels of the conjunctiva, which will be seen carrying red blood to the part. The veins corresponding to the nebulous parts will become turgid and prominent. If there be considerable inflammation, it must be removed by active means; and in these cases it will be proper to deplete. The inflammation, however, is generally of the chronic kind, and arises from a relaxed state of the vessels, which require stimulating applications, in order that they may recover their tone, and convey the blood uninterruptedly. If the vessels be stimulated, the blood will be likely to flow through the veins; the absorbents will be excited, and remove the effused lymph. By stimulating applications, the cornea will frequently be restored to the same state of transparency as before the attack. Care must be taken that in the treatment no undue degree of stimulus be employed; if there should be inflammation it will be increased, and the complaint be as bad or worse than ever. A collyrium that may be used, is one with the sulphate of zinc, containing about a grain to an ounce of water, gradually increasing it in strength. One which has been recommended, is that with the corrosive sublimate, with a grain to an ounce of water. Calomel or levigated sugar has been used in many cases with good effects. This is quite an old woman's remedy, and has been recommended very indiscriminately. Unscientific persons—those who are not acquainted with the nature of the disease in which it is useful—seeing it do good in one complaint, think it will in all others of a similar appearance, though essentially different in their character, and therefore employ it in cases where it does

harm, using it alike in a cicatrix from ulceration as in nebula arising from a deposit of lymph. In the one, if it be employed, loss of substance will be the result—inflammation will be excited, and fresh ulcers will form. In the other, that is, in nebula, it will often be of service, care being taken not to produce an over degree of stimulus in the part.

SECTION 5. PUSTULES.

Pustules are generally seated at the junction of the transparent with the opaque cornea ; but they may sometimes occur in the cornea itself, or the conjunctiva covering it, or the ball. They are seated in different parts. The appearances that they present at first are red or yellowish spots arising from a deposit of lymph in those parts, and are slightly elevated. There is considerable turgescence of the vessels around them. If they occur on the cornea, it will be nebulous and opaque ; the vessels round the cornea will be seen distended, carrying red blood, and having a radiated disposition. If the lymph be not removed by absorption, the pustules break, matter escapes, and ulcers form in their place. Sometimes there is only one of these ulcers, frequently two, one at each side of the cornea, just at the junction of the transparent with the opaque cornea, and occasionally the cornea is even encircled by them. Although the inflammation accompanying the formation of pustules is not acute, yet it frequently happens that there will be more or less pain on moving the eye, intolerance of light, and effusion of tears.

These ulcers are difficult to manage, as they often oc-

cur in the scrofulous habits of body and broken-up constitutions, and are apt to become chronic, and consequently difficult of cure. When the healing of the ulcers takes place, and the same state of body continues, they are soon reproduced, and the disease is greatly aggravated. As for the treatment this affection requires, it will be hardly necessary to say, that if considerable inflammation exists, depletion must be employed. The inflammation, however, is of the atonic kind. First apply leeches, but not in large numbers, so as not to carry depletion to too great an extent; it will be proper to evacuate the bowels, not by drastic purges, but mild aperients, and to attend to the secretions. Blisters will be useful if the sight be affected. When the state of the bowels has been regulated, begin with tonic remedies, and as early as possible with mild astringent collyria, and the best is the vinum opii. The only point to guard against is, that depletion be not pursued to too great an extent at the outset. The system must be invigorated by tonic remedies, and tone given to the vessels of the part.

SECTION 6. FUNGUS OF THE CONJUNCTIVA.

This appearance of the conjunctiva occurs in diseased subjects. The conjunctiva becomes loose and red, the vessels turgid with blood, and there is a fold of this membrane on the inside of the lids, which produces considerable irregularity on its surface—a morbid secretion is kept up on the part—and not unfrequently eversion of the lids is the result. Extraneous bodies often enter the eye, and disturb it considerably. To prevent this, and remedy the complaint, the loose portion of the conjunc-

tiva should be removed, which is a very easy operation. An assistant holding the lid, you, by the means of a pair of forceps, raise the fold of the conjunctiva, and with a pair of curved scissors remove it. As to the after-treatment, you must keep down inflammation, should it appear, by the means already recommended.

SECTION 7. GRANULATIONS OF THE CONJUNCTIVA.

These are nothing more than loose irregularities of this membrane where it lines the lids. These projections continue to pour out a portion of morbid secretion, which stimulates and irritates the whole eye; the palpebral conjunctiva becomes altered in its texture, and its surface is covered with fleshy elevations, having the exact appearance of granulations. These granulations covering the surface of the conjunctiva lining the lids are constantly rubbed over the globe of the eye whenever it moves, producing pain and irritation, and keeping up morbid secretion, and, in fact, giving rise to chronic ophthalmia. Thus easy access is afforded to extraneous bodies, nebulous opacities form on the cornea, vessels will be seen shooting over it, and these will be quite in a varicose state, enlarged, and having a knotty appearance. The granulations, if not removed or remedied, produce ultimate blindness.

Considerable advantage is said to be derived from removing the granulating surface of the conjunctiva by the lancet, or by a pair of curved scissors. Touching the granulations with nitrate of silver or sulphate of copper will tend materially to keep them down. The liquor

plumbi subacetatis applied to the surface of the granulations has been tried by Mr. Tyrrell with advantage. The result of Mr. Green's experience has been to confirm this statement. If the vessels on the cornea be numerous, it will be proper to divide the trunks which supply them. This is a very simple operation. Raise the lid and press on the globe, by which means it is distended and projected forwards; then carry a sharp curved instrument round the outside of the cornea, and divide the vessels, so that they shall not reunite. A bar of lymph is thrown out, which turns the vessels from off their course, excepting perhaps, the small ones, which often reunite. It will be necessary, perhaps, to repeat it. Cases of this complaint are difficult to cure. These are, then, the remedies to be used: removing the granulations, applying caustic applications, and the division of the varicose and enlarged vessels. These may be aided by setons, issues, blisters, and attention to the general health.

SECTION 8. PTERYGIUM.

This is all of the triangular shape, and may be divided into the membranous and fleshy. The first has the appearance of a thin film of minute vessels converging towards the cornea. The usual seat of this affection is towards the inner canthus, that is, with the base at the canthus and the apex against the cornea. It is always of a triangular shape, and the vessels proceed from the base to the apex. The fact is, that pterygia do not long exist before they produce a nebulous state of the transparent part of the eye by deposits of lymph, and then of fluid.

The conjunctiva and sclerotic coat become loaded with vessels, and if this affection is not remedied, vision becomes impaired, and is ultimately lost. The fleshy pterygia differ from the membranous, and are more vascular. They first appear of a yellowish colour. Then the vessels running through them become large, and they have a red appearance; but always retain their triangular shape. When the disease has proceeded far on the transparent part of the eye, the only plan to adopt will be the removal of a part of the pterygium. This consists simply in raising the membrane as near as possible to the cornea, and cutting it through while suspended. When the pterygia are fleshy, more care must be taken in dividing them; they must be divided near to the margin of the cornea, and turned back from the apex towards the base.

CHAPTER IV.

INFLAMMATION OF THE PROPER TUNICS.

SECTION I. INFLAMMATION OF THE CORNEA.

At the outset, in inflammation attacking the transparent cornea, there is a hazy appearance, the cornea loses its natural lustre, and in a short time there may be discovered on its surface, vessels carrying red blood, and then the symptoms will be the same as those of inflammation in general; the patient will complain of intolerance of light, and also have effusion of tears. When the in-

flammation of the cornea continues, matter very frequently forms between its lamellæ, and the appearance which it then assumes is called *onyx* or *unguis*, from its resemblance to a nail ; the matter is to be very distinctly seen in the transparent part of the eye, and gradually extends till it occupies one third or fourth of the cornea. If the eye be placed in profile, yellowish spots may frequently be observed, which are usually seated at the anterior part of the cornea, and if gentle pressure with a probe be employed, the fluid may be felt fluctuating within. In the various positions of the head, the matter does not shift its situation, but remains in the same spot. By proper treatment the matter often becomes absorbed, but it not unfrequently makes its way externally, or an opening is formed internally, and the matter then is effused into the anterior chamber of the eye.

SECTION 2. ULCERATION OF THE CORNEA.

This disease is the common consequence of inflammation of the cornea; but it is very frequently produced by the contact of matter in purulent ophthalmia, and the irritation of lime, or by any sharp pointed bodies which may be insinuated into the cornea ; or, in fact, any irritating substance, mechanical or chemical, that may be introduced into the eye. The inflammation produces the formation of pus—this breaks, and an ulcer is formed. In ulcers of the cornea the edges are rugged, uneven, and elevated, the ulcer itself having an ash-coloured appearance, and the patient complaining of great pain ; there will also be a discharge of a good deal of acrid and

irritating matter. In general there will be no difficulty in distinguishing ulcers of the cornea; put the eye in profile, take a side view of this organ, and the ulcer will be seen with the appearances already described. The situation of ulcers of the cornea varies; very frequently they are at the superior portion, and affecting only the external lamellæ, in other cases spreading over the whole cornea, and penetrating into the anterior chamber, by which means the aqueous humour escapes, and the iris is often protruded: sometimes even the opening becomes enlarged, and the crystalline lens and vitreous humour escape. The ulcers vary in their appearance, some being large and others small, and those which are of small size, on cicatrization, do not materially obstruct vision, whilst those that are large, when healed, produce a nebulous appearance which destroys the power of sight.

Treatment of inflammation and ulceration of the cornea.

The treatment required in inflammation of the cornea does not differ materially from that of inflammation of the conjunctiva, or any other part of the eye, and therefore it will not be necessary to recapitulate the means necessary to be adopted: rely on the efficacy of a strict antiphlogistic plan, and when the acute inflammation has been subdued, on the use of mild astringent collyria. When ulcers, however, form in any part of the cornea, it will be proper to use active means, if they be accompanied by acute inflammation; but most frequently they are accompanied by chronic ophthalmia, and have a disposition to spread rather than heal. In these cases as-

tringent lotions will be of great service; but of all remedies in ulcers of the cornea, the nitrate of silver is the one on which you are to depend; it is generally used in a state of solution, about two grains to an ounce of water, or it will be better to begin with a grain to an ounce, regulating the strength in proportion to the degree of irritation it may produce. Scarpa gives the preference to the caustic itself in the treatment of the ulcers of the cornea; the caustic is to be cut to a sharp point, and the ulcer to be touched with it. An eschar forms, which, in the course of two or three days, falls off, and the symptoms of the disease return as before; the caustic is again to be applied, and to be repeated a third time, if necessary. The ulcer, by this means, loses its ash-coloured appearance, the edges become regular and even, and it rapidly heals. When ulcers of the cornea are attended by acute inflammation, it will be necessary to employ bleeding, by leeches, before the use of astringents, and at the same time to keep the bowels regular by mild aperients. During the progress of the ulcers, it will be necessary to watch them very closely, and examine them frequently; but in doing it great caution must be used, lest the eyelids become everted. When the ulcers heal, it is by cicatrization, as in any other part of the body, and afterwards specks are left which are nothing more than rounded spots of coagulable lymph, and are denominated *leucoma* or *albugo*; and in these cases the rays of light are not prevented entering the eye, except when the spots are on the axis of vision, and then they are interrupted.

SECTION 3. STAPHYLOMA.

In this disease the cornea becomes opaque, considerably elevated, and altered in texture. The eyelids are prevented from being closed; there is perpetual irritation kept up by the friction of the palpebræ on the ball. This disease frequently comes on after small-pox, and is one of the sequelæ belonging to that formidable complaint. By the separation of the lids, extraneous bodies often enter the eye; irritation is produced by the friction of the lids and eyelashes—and thus a considerable degree of inconvenience is produced to the patient, and the eye kept in a state of chronic ophthalmy; and the sound eye becomes sympathetically affected.

In this disease the iris often protrudes; the vitreous humour is altered in texture; and the crystalline lens is projected forwards. In this complaint nothing can be done for the restoration of sight; and the only plan of treatment will be to remove the staphylomatous part, so as to return the eye within the orbit, and permit the use of an artificial eye. The operation is exceedingly simple; the surgeon first passes a needle with a ligature through the staphylomatous part, in order to steady the eye, and then with the other hand takes the cornea knife, and removes as much of the projecting part as may be necessary. The operation gives little pain; it generally happens that the iris adheres to the cornea, and that portion of it is removed. The crystalline lens escapes, together with a portion of vitreous humour, and the eye collapses, so that when the part is healed, an artificial eye may be worn. These are now made so much to resemble the natural eye,

that they may be worn without the deception being detected. This is the only treatment that can be adopted with any relief to the patient. The cornea sometimes becomes conical, or of a conoid shape; in these cases the cornea loses its natural lustre—the sight becomes impaired. Glasses afford no relief to the sight in this altered shape of the cornea; nor is there any remedy known that does. Mr. Green has seen several cases of this kind, and has not known any good result from the treatment that has been adopted.

SECTION 4. INFLAMMATION OF THE IRIS.

Inflammation of the iris, or, as it has been latterly called, *iritis*, is a peculiar and specific inflammation of the eye. The symptoms attending this complaint are in some cases with great difficulty recognized. In looking into the eye, the iris is observed to be changed in colour, or having a brownish hue; or rather a reddish brown colour, (this, however, varies according to the natural colour of the iris,) from the increased number of vessels on its surface carrying red blood. The iris itself is altered in texture, being puckered and thickened. These appearances are soon removed, and deposits of yellow lymph, resembling yellow tubercles, will be seen on the iris; the pupil becomes irregular, and altered in shape, and the pupillary margin of the iris thickened, and turned back towards the posterior chamber. These, then, are the principal symptoms by which iritis may be recognized; but, besides these, the aqueous humour becomes turbid, and the ciliary vessels on the surface of the sclerotic form a zone of vessels immediately surround-

ing the upper part of the cornea, which have a different appearance from those in inflammation of the conjunctiva, the latter having a tortuous course, whilst the others go in a straight direction. The conjunctiva partakes of the inflammation, and assumes a red appearance. The pain in the eye is not acute, but the patient cannot bear the light. There is also considerable constitutional irritation or fever, which may be known by the state of the pulse, and other symptoms. Inflammation of the iris often comes on from very slight causes; it occasionally happens to those who have been under the influence of mercury, and in persons of a scrofulous diathesis, or when mercury has been pushed to an undue extent.

Iritis has, in consequence of its occurring so frequently after syphilis, been classed as a secondary symptom of that complaint: Mr. Green entertains considerable doubt on the subject, for he says he has never met with it in a person labouring at the same time under any other secondary symptoms of syphilis, with eruptions or nodes on the bones: and also has never met with a case of iritis after syphilis, but when mercury had been previously given, and therefore he is doubtful whether the inflammation of the iris was the effect of the mercury, or of the original disease for which it was given.

Ophthalmitis.—Iritis is not unfrequently accompanied by inflammation of the tunics of the eye—what may be called *ophthalmitis*, or deep-seated inflammation of the globe of the eye. In this complaint the sclerotic appears reddened—the cornea is dull, and the capsule of the lens itself becomes opaque: all these participate in the inflam-

mation. There is deposition of lymph on the edges of the iris, and there are also adhesions of it in some places to the crystalline lens. The sclerotic coat, however, is particularly inflamed: the vessels may be seen carrying the blood in a straight course, while those of the conjunctiva are tortuous. There is pain in the eye, intolerance of light; also these symptoms, together with a turbid state of the humours, are sufficient to inform one of the presence of inflammation of the sclerotic coat: the patient also labours, at the same time, under great febrile excitement. This inflammation is often attended by a disorganization of the organ.

Hypopium.—The result of this severe form of inflammation, if it be not checked, is effusion of lymph or matter into the anterior chamber of the eye, producing what is technically called *hypopium.* In these cases the matter may be easily observed, and sometimes there is so much as to conceal the edges of the pupil and the iris.

Treatment.—Of course the first part of the treatment will be to relieve the irritation of the part by blood-letting, both general and local; and, in fact, all the steps of depletion must be adopted, as in other inflammations of the eye. But there is one remedy above all others in this complaint on which you are to rely, and that is mercury: it must be given so as to affect the constitution, till the gums and mouth are sore, or the saliva begins to flow, which will be the signs of it. In iritis, this medicine must be given, whatever quantities may have been taken before. The best form in which it can be exhibited is that of calomel; let it be given internally after the bleed-

ing in the dose of two or three grains, combined with about a third or a quarter of a grain of opium, so as to prevent its acting on the bowels.

In order that the calomel may affect the system, it must be given every fourth or sixth hour, till the mouth is sore; in more chronic forms of this complaint, it may be given less frequently. As soon as the system has become affected, the zone of vessels will gradually disappear, the lymph become absorbed, the aqueous humour become clear, and the cornea lose its hazy appearance. Other remedies have been recommended, but the exhibition of mercury alone can be relied on. The belladonna will be found a very useful adjunct in this complaint; by dilating the pupils, the adhesions are often prevented from forming between the iris and capsule of the crystalline lens, and when they are formed it tends to elongate the adhesions. The belladonna should be applied, in the form of extract, around the eye, morning and evening.

SECTION 5. AMAUROSIS.

By amaurosis, is meant partial or total loss of vision, arising from paralysis of the optic nerve or retina; and this is produced by a congestion of the vessels of the part, or minute alteration of its structure. The symptoms distinguishing this complaint are few, and therefore require to be well known. The pupil is generally dilated and motionless; the iris is nearly immoveable, acts very little, and vision is completely destroyed. There is also slight strabismus. In amaurosis, there is frequently the sensation as if a cloud were before the eye, which is termed

caligo; and there is often a greenish appearance of the humours, this is named *glaucoma*, and depends on an alteration of the lens, or an alteration in the structure of the vitreous humour. The persons subjected to this complaint are those who have been in the habit of viewing minute objects, or exposing the eyes to strong light. Persons affected with amaurosis are frequently troubled with false appearances—as flashes of light, or balls of fire before their eyes. The causes of amaurosis may be divided into three parts:—1st, Those which affect the retina or optic nerve. 2d, Those affecting the brain, or that part of it from which the optic nerves arise, the *thalami nervorum opticorum*. And, 3dly, Those affecting the body at large, or some particular organ, and thus sympathetically affecting the eye.

As causes of the first and second, we may enumerate:—

1. Lesion, extravasation of blood, inflammatory deposition upon either of its surfaces, and loss of transparency of the retina.

2. Morbid growths within the eyeball, dropsy, atrophy, and all such disorganizations as directly oppress or derange the texture of the retina.

3. The state of apoplexy, hydrocephalus, tumour or abscesses in or upon the brain, the optic nerve or its sheath; and thickening, extenuation, absorption, or ossification of the latter.

As causes of the third:—

1. Temporary determination; vascular congestion or vacuity, as from visceral and cerebral irritation; suppressed or deranged, or excessive secretions, as of the

liver, kidneys, uterus, mammæ, and testes ; various forms of injury and disease ; and sudden translations of remote morbid actions.

2. Idiopathic paralysis, suspension or exhaustion of sensorial power from various constitutional and local causes ; from undue excitement or exertion of the visual faculty ; and from the deleterious action of poisons on the nervous system, as lead, mercury, &c.

The third division, or *functional amaurosis*, admits of the following subdivisions :—

1st. *The symptomatic*, or that which is only a symptom of some general disease or disorder of the system, as for example, general plethora, general debility, &c.

2d. *The metastatic*, or that produced by the sudden transference of the morbid action from another organ of the body ; as for example, from the skin, the testicle, &c.

3d. *The proper*, or that which immediately depends upon a peculiar condition of the retina ; as for example, the visus nebulosus, muscæ volitantes, &c.

Diagnosis.—Amaurosis depending on a change of structure in the brain or eyeball, is an irremediable case. The same may too often be said of that which presents no evidence of structural disease. For there are certain cases purely functional, so nearly approaching in character to the organic class, as at once to convey the impression of their irremediable character. On the other hand, cases are of frequent occurrence which admit of material and decided improvement, and even of complete recovery.

Treatment. The treatment of amaurosis is almost exclusively constitutional, and must be of the antiphlogistic kind. The cure, in fact, of amaurosis, like that of in-

flammation of the iris, turns upon two points; the employment of ordinary antiphlogistic means, that is, the abstraction of blood either generally or locally, with other antiphlogistic remedies, and afterwards the use of mercury, so as to affect the system: indeed, mercury appears as effectually to check the progress of inflammation of the retina as it does that of the iris, and it acts as beneficially in checking the progress of the chronic inflammation of the retina, which is the ordinary cause of amaurosis, as in checking the progress of the more active affection which would constitute *retinitis.* In order to derive the full advantage which this remedy is capable of rendering, it is necessary in these cases to produce its peculiar action on the system, and sometimes to keep it up for several weeks. Such at least is the opinion of Mr. Lawrence, who says that "it is not sufficient just to render the action of the mercury sensible on the mouth, and then to discontinue it; pretty active salivation must be kept up for weeks in order to enable you to derive all the benefit which the remedy is capable of affording." Mr. Travers, on the contrary, thinks, that "no advantage is obtained by salivation;" he considers it positively hurtful; and that "when mercury is beneficial, its efficacy is perceived as soon as the mouth is sore." The form of its administration must be regulated by the circumstances of the case.

In the treatment of this disease counter-irritants are sometimes useful auxiliaries. These, if managed as the case directs, are of great value; in some, as temporary irritants only, in others, as irritants and drains. It may sometimes be necessary, in conjunction with other treatment, to apply a blister, every five or six days, to the back

of the neck. Other plans of treatment have been recommended; cupping, issues, and setons, have been severally employed with advantage. The employment of electricity also has been recommended, but has hitherto been attended with little or no benefit.

The *constitutional treatment* necessary in amaurosis is various according to the circumstances. Extremes, it is said, meet, and it is certain that a strong and delusive similarity often prevails between the signs of diseases, which result from conditions diametrically opposite. In cases of general plethora and of cerebral compression, the treatment is obvious enough. Under an idea that the deficient state of vision arises from weakness of the nerve, all kinds of tonics, stimulants, antispasmodics, have been tried without any good result. Neither has the emetic practice recommended by Scarpa, been successful in this country. In most of these cases, we must depend, first, on the regulations of the visceral functions; and secondly, on the employment of such restoratives as the system requires and can bear. The blue pill, with colocynth, rhubarb, or aloes, and the combination of soda with rhubarb and calumba or gentian, are best adapted to the former purpose. The exhibition of general tonics is often strongly indicated, and much benefit has been derived from the mineral acids, bark, steel, when admissible, and arsenic after a due regulation of the digestive functions.

Superadded to the entire repose of the organ, the natural tonics, viz., a pure dry atmosphere, the cold bath, horse exercise, nutritious diet, early and sufficient rest, agreeable society, and a mind as much as possible diverted from the object upon which it is unfortunately and pertina-

ciously prone to dwell. These are of more avail than drugs; and some lighter forms of sympathetic amaurosis are as effectually cured by them, as by blue-pill, rhubarb, and on the self same principle.

CHAPTER V.

AFFECTIONS OF THE HUMOURS OF THE EYE.

HAVING described the affections of the coats of the eye, it is necessary in the next place, to treat of those of the humours of the eye. Very little, however, can be said of the aqueous and vitreous humours, as most of the diseases to which the humours are subject, attack the crystalline lens, or its capsule.

SECTION 1. HYDROPHTHALMIA.

The aqueous humour is sometimes the subject of an accumulation which is known by the name of *hydrophthalmia* or dropsy of the eye; and consists of an increased secretion of this humour. The symptoms of this complaint are—that the eye becomes more distended than natural; the cornea widened; the sclerotic coat attached to the cornea has a blue tint or cast: the sight is affected; the motions of the iris impaired: and the disease at last terminates in amaurosis. On what this complaint depends, it would be difficult to say: it is generally preceded by chronic ophthalmia.

Treatment.—The remedies recommended for this complaint are various, of the most opposite kind, and have

been tried generally without any good effect. Puncturing the cornea, at a short distance from the sclerotic, has been tried, and it is said with success. Mr. Green has seen several cases of this affection, in which no benefit whatever was derived from any means that were employed.

The *vitreous humour* is occasionally affected. There is sometimes a deficiency of this humour, arising from part of it being lost in the course of an operation: and the quantity lost is often so considerable, that the part supported by the aqueous humour is not sufficiently firm to keep up the natural roundness and plumpness of the eye. The medium of refracting the rays of light is destroyed, the sight becomes impaired, and glasses afford no relief.

There is the tremulous iris after couching, arising from the same cause as the preceding affection. Another change which takes place in the vitreous humour is that known by the name of *glaucoma*.

SECTION 2. GLAUCOMA.

In this complaint the vitreous humour becomes altered in texture, more dense, and presents a sea-green hue, and the pupil is dilated. This disease has often been mistaken for cataract, and a person affected with it is frequently supposed to have a cataract in its incipient stage. On examining the eye minutely, this greenish appearance may be observed to be behind the crystalline lens, and posterior to the seat of the cataract; it may be, however, mistaken for many diseases, and has a greater resemblance to cataract than any other. Glaucoma remains without any change by which it may be distinguished from fungus

of the eye, which will be described presently. The diagnosis is not difficult.

SECTION 3. CATARACT.

By cataract, is meant a partial or general opacity of the crystalline lens, or of its capsule, or of the liquor Morgagni which intervenes between them, or of all these taken together. Cataract from opacity of the humour Morgagni, is very rare, and in the belief of some, purely hypothetical. This complaint seems to have been understood by Hippocrates; but the notions of Galen, and those who followed him, respecting cataract, were very confused; and it was not till the end of the 17th, or beginning of the 18th century, that the nature of this disease began to be understood, when Merry and Maitre-Jean, and others, gave fair accounts of this complaint.

The symptoms of cataract are unequivocal, and may be easily recognized. At first there is always defect of vision, and the patient sees things as through a mist, and requires a strong light to see them plainly; this symptom changes during the progress of the complaint, the patient being able to see better in a moderate than a strong light; and then a speck or opacity in the lens or capsule may be distinctly observed; it is generally in the centre of the pupil, and the situation of the lens; this gradually enlarges, and, in proportion as the opacity increases, the sight becomes more dim, and the capability of discerning objects diminishes. In the progress of the cataract, the patient can see better in a faint than in a strong light; and this is easily explained, because in the faint light the iris dilates, and the rays

of light are transmitted through the circumference of the crystalline lens, which is not yet obscured.

But as these symptoms differ in the different varieties of this disease, this leads to the consideration of the different species of cataract: it is extremely important that they should be known, as the operation necessary to be performed, depends on the kind of cataract which exists; but it is to be observed that the criteria are, to say the best of them, very fallible. On looking at a cataract, a surgeon cannot always be certain that it is of this or that kind, but on the whole is enabled to give a pretty good guess. The symptoms characterizing each kind will be described under their different heads.

Different kinds of cataract.

There are four kinds of cataract: 1st, the hard or firm cataract; 2d, the fluid or milky cataract; 3d, the soft or caseous cataract; and, besides these, there is a fourth kind, the capsular cataract; the three first forming in the lens itself, and the last in the capsule.

The last kind of cataract comes on after an operation or in consequence of it, and is also found in children, when it is called congenital cataract. This kind of cataract does not differ essentially from the other forms of capsular cataract, but is called congenital, on account of its occurring at a particular period of life, or children being born with it. This form of cataract also requires a particular kind of operation, and will be particularly spoken of.

Of the lenticular cataract there are three kinds, the soft, fluid, and hard. These different kinds of cataract

occur at different periods of life. It is stated that the firm or hard cataract is found in advanced age, whilst the soft occurs at an earlier period. There is one circumstance respecting these different kinds of cataracts it is necessary to mention; that is, it is not at all common for one form to go into another—for the soft to go into the hard, for instance, is exceedingly rare. This remark is the more necessary, in consequence of an opinion which used to prevail, that a soft cataract became hard, and then it was said to be ripe. This idea is now given up, and experience proves it to be incorrect.

Let us now consider the different symptoms attending the different kinds of cataract.

a. Firm or hard cataract.

In this kind of cataract the lens acquires a greater degree of density or firmness than natural; and in undergoing this change, it becomes smaller and thinner, and more concentrated. If you look at the cataract, you will see that it has not the natural whiteness of that complaint: it has a yellow or brownish appearance, the colour of amber. The next particular to be observed is the interspace between the iris and front part of the lens, on account of the lens becoming thinner. The motions of the iris are free, there being no adhesions. There is generally some degree of vision, and the patient can often discern large and bright objects, and even differences of colour, and sometimes the shadow of minute objects. When the light is faint, the patient can see more distinctly than when it is strong. This kind of cataract generally occurs at an advanced period of life. By these

symptoms, then, may this kind of cataract be distinguished :—by its colour and size, the interspace between the front part of the lens and the iris : the vision being more or less distinct ; and, lastly, by its occurring at an advanced period of life.

b. Fluid cataract.

This kind of cataract is always more or less fluid, and is called milky, from its white colour. The fluid cataract is not of equal density throughout. If the eye of a patient be examined with attention, a flocculent appearance will be observed, from specks or streaks consisting of solid particles of the lens, and these will move up and down in the various positions and motions of the head, and be removed out of sight ; but on the head becoming steady, they again appear. This arises from their gravity ; on motion, they sink to the bottom, and of course disappear. There will not be any difficulty in recognizing this form of contract. Besides these symptoms, the lens becomes enlarged and globular ; and the increase of size is such, that the lens reaches to the iris, so that there is no posterior chamber at all. If the surgeon look at the eye in profile, he will see that the iris is protruded forwards ; from this pressure the motions of the iris are sluggish, and in some cases prevented altogether. The size and shape of the pupil is altered. The rays of light do not pass into the eye, and the patient can scarcely tell the difference between light and darkness.

c. Soft or caseous cataract.

This kind of cataract is of the consistence of firm jelly

or cheese. It is uniformly opaque, and there is a milky whiteness, as in the fluid cataract; but the spots and streaks, sometimes observable in this form, never shift their position, as in the other; the lens also becomes increased in size. The posterior chamber is obliterated. There is no interspace between the fore part of the lens and iris. The motions of the iris are performed with difficulty, from the size of the lens, and the rays of light are prevented from entering. The patients sometimes cannot distinguish between light and darkness; although they are seldom so blind as this.

d. Membranous or capsular cataract.

This form of cataract is not connected with the lens, but the capsule itself. This opacity may exist either in the posterior or anterior layer of the capsule, or combined with that of the lens, and thus produce cataract. In this last case there is no distinct mark of diagnosis; but when the capsule only is affected, the surgeon may offer an opinion. If the anterior layer of the capsule is opaque, it has the appearance of being superficial and close to the pupil, and appears rather nebulous. It does not quite lose its transparency, but becomes semi-transparent. When the posterior layer is affected, this appearance is deeper; being at a considerable depth, and having more or less of a concave form. There are also striæ passing in a radiated direction. If, then, the opacity be deep-seated, and the lens appears concave, the surgeon may conclude that the posterior layer of the capsule is opaque; but when this state is combined with opacity of the lens, the diagnosis will be difficult.

Another species of membranous cataract is, when the capsule becomes opaque, and the lens at the same time absorbed, and a tough, dense, membranous substance is formed, as in congenital cataract.

These are the different diagnostic marks for detecting the different kinds of cataract; and, from the nature of the observations, it will be evident how difficult it is to distinguish them. But it is necessary, as far as is possible, to be acquainted with the appearances each form of cataract presents, as the treatment or operation required must be adapted according to the kind of cataract.

Causes of cataract.

The causes of cataract are in general very obscure. Cataract sometimes arises from obvious causes—injury, violence, inflammation, or sharp-pointed bodies wounding the capsule of the lens, or the lens itself, and consequently producing opacity of these parts. The opacity arising from this cause often becomes absorbed, and the case undergoes the natural process of cure without requiring an operation. It is produced too by inflammation of the globe of the eye; but then the cataract is capsular, and not lenticular.

Cataract, however, arising from these causes, is exceedingly rare; and by far the greater number of cases are produced, as it is called, spontaneously, or under circumstances which are too subtle for our cognizance. It has been said that where the eye has been tried a good deal, and subject to much exercise and strong light, as in blacksmiths, glass-blowers, &c., that cataract is produced; this is exceedingly doubtful; and if it is so, there are many

cases in which no such cause can be assigned. It is also not unfrequently congenital, and of course produced from none of the causes mentioned. It also runs through families, and appears to be hereditary. It has been shown that it may be produced by external causes which are obvious, yet it more frequently comes on without any assignable cause.

Prognosis.

Of course, by this is meant a prognosis as to the issue of the case by an operation; it is desirable, therefore, to ascertain whether service can or cannot be afforded by the operation; whether the changes which the eye may have undergone from inflammation during the progress of the complaint, or the symptoms, are such as to preclude the chance of success if an operation were performed, and destroy all hopes of vision ever being regained. Now there are certain symptoms accompanying this affection, by which the surgeon is enabled to form a pretty accurate opinion as to the issue. There are some extremely valuable observations on this part of the subject to be found in Scarpa's work on the diseases of the eye.

The first circumstance which leads you to determine as to the success of the operation is, whether the loss of vision has been gradually supervening, and has always been in proportion to the opacity of the lens; second, whether the cataract has been accompanied by chronic ophthalmia, or any changes have been produced in the eye by it: if the cataract has been attended by a penetrating pain in any part of the eye, or orbit, or back of the head,

which it will be necessary to inquire about; third, whether the motions of the iris are duly performed, in the different variations of the light; if not, fear may be entertained of the eye being amaurotic; fourth, if there is the power of distinguishing between light and dark, or the colour or forms of things, or the shade of passing objects.

These circumstances should be particularly inquired into; and if the patient has all, or the greater part of them—that is, if the defect of sight has been increasing just in proportion to the increase of the opacity of the lens, and the patient has had no pain in the head, and the motions of the iris are free, and light can be distinguished; then the surgeon may operate, and with the chance of success, as there are no evident reasons against it.

For by the first circumstance we learn that the vision has been impaired in consequence of the opacity of the lens; by the second, that there has been no disorganizing inflammation in the eye, or that the brain and origin of the optic nerves have been affected; by the third, that the retina is sound; and by the fourth, if the opacity of the lens be removed, that the retina will be in a state to receive the impression of external objects. But these signs are not so certain as they might appear, for the iris might act, and yet amaurosis exist: and if one eye were not closed, the motions of the iris of the other might be prevented, by sympathy from the other. Thus it appears that the state of the iris does not always determine the existence of amaurosis.

When there is cataract the operation must be regulated by taking all the circumstances into consideration; by the

figure of the cataract; whether there are any adhesions of the iris to the capsule of the crystalline lens; and especially by the patient being able to distinguish objects, and light from darkness; but though this is a favourable symptom, yet persons may have amaurosis, and be able to distinguish day from night, and even objects from one another. On the whole, it is a very favourable symptom, and when present, the operation may be performed. In general, when the case is doubtful, the surgeon had better perform the operation, of course taking care to inform the patient of the state of the case: the pain is not great, and you will not leave the patient in a worse state than before the operation. It would be extremely culpable for any one to operate where it was quite apparent that no relief could be afforded; and yet individuals have operated where there was no more chance of doing good, than if the eye had been scooped out of the head—such men are unprincipled, and would undertake any thing for the purpose of gain.

Another question to be determined on is, whether the operation should be performed if one eye only is affected? The answer appears to be plain, yet there are some who contend that the operation should be resorted to when there is cataract in one eye only, and their principal reason is this: they say, that it is known a sympathy exists between the two eyes, and that if a morbid action is set up in one, it will be excited sympathetically in the other, and thus disease be communicated to the one which is sound, and an operation be required to be performed on it. This is scarcely a sufficient reason, because under so little excitement, the chance of the other being affected

is slight. The disadvantages of this plan are various; it is true that a sympathy exists between the eyes, and that if inflammation is set up in one, it will be excited by sympathy on the other, which may destroy the organ that is sound. But suppose success attends the operation, what is the effect? the focus will be different, and the patient will not be able to use both eyes at the same time.

Next, where there is only one eye sound, and it performs its office well, and vision is good, it will be better to wait till it becomes dim; then the operation for restoring the patient to sight may be performed, and two chances be in the patient's favour. Therefore it seems that in performing the operation for cataract, where one eye only is affected, the patient is exposed to the risk of losing the sight of both. The plan that appears to be the best is, not to operate except both are affected; then the operation may be safely performed.

CHAPTER VI.

OPERATIONS FOR THE CURE OF CATARACT.

Before speaking of the operation for cataract, it will be expected perhaps to premise by saying something of the treatment; but besides an operation in this complaint, very little else in the way of treatment will be of use. Various plans of treatment have been adopted, but without success; therefore, it is better at once to describe the operations. The operations for cataract are three in number—first, depression, or couching, by which the

cataract is removed from the axis of vision; second, extraction, which consists in making an incision through the cornea; third, the operation for the solution of the cataract.

SECTION I. OPERATION FOR DEPRESSION OR COUCHING.

This mode of operating consists in removing the opaque lens out of the axis of vision, by depressing it into the vitreous humour: this is done by a needle, of which there are three different kinds now employed, Hey's, Scarpa's, and Beer's needles.

Hey's needle is about seven eighths of an inch in length; it is rounded except at the point, where it is flat for the eighth of an inch; it terminates by a semicircular cutting edge, which ought to be exceedingly sharp. Scarpa's needle is more slender than the other, and curved at the point. When you look at it sidewise, it presents a flat convex appearance on the dorsum, it is of a triangular shape towards the point, and has also a concavity; it is sufficiently strong to depress the lens. The next is Beer's spear-pointed needle; it is narrow at the neck.

Mr. Green gives the preference to the latter instrument; a surgeon is not so likely to wound the ciliary ligaments or processes with it. The needle is the only instrument required; some use a speculum, but, excepting in children, this will not be of much use. Previous to the operation, very little preparation will be necessary; of course, the surgeon should ascertain whether the patient is in good health, see that the bowels are regular, and that all the functions are properly performed.

Mode of operating.

We next come to the mode of performing the operation. The light, and the position of the patient and operator, are extremely important, and all to be attended to. The light should be clear, distinct, and full, but not vivid, and it should not fall on the centre of the eye of the patient, but laterally, else it would produce a dazzling, and unsteadiness of the organ. The patient should be placed on a low seat with a high back, and the head resting against it, or the body of an assistant. The operator should be on a high stool, or at least of sufficient height to enable him to put one foot on it, and rest his elbow on the knee opposite to the eye to be couched. Having thus prepared himself, the operator holds the instrument between the thumb and fore-finger, the assistant passing his fore-finger round the head of the patient, raises the upper lid by a fold of skin, and presses it gently against the superciliary ridge. The patient is now directed to look inwards towards the nose, and the operator, resting his little finger on the upper part of the chin of the patient, penetrates the sclerotic coat about a line and a half from the junction of the transparent with the opaque cornea, and a line below the transverse diameter of the eye.

In the first place, the needle is introduced here, just where the retina terminates, and the ciliary ligament commences, so that these shall be avoided; and, 2dly, for the purpose of not wounding the ciliary artery, as it goes along the middle of the external convexity of the eyeball, between the sclerotic and choroid coat. In using Beer's needle, it is introduced with the edge laterally, and its

surface upwards and downwards, and directed towards the middle of the globe of the eye. It must be moved slightly between the fingers; a piece of ivory or brass at the handle showing the disposition of the cutting edges, and then the point carried inwards parallel to the iris, and so as to cover the posterior chamber; the instrument will be now visible through the pupil. When this is the case, the operator must raise the needle upwards, and then depress it downwards, and backwards, and a little outwards, by which means the crystalline lens becomes pushed into the vitreous humour. If the lens should rise from its situation, it must be again depressed, and when it is safely lodged in the vitreous humour, the needle must be withdrawn.

Some continental surgeons perform the operation of *reclination*, which consists in turning the lens over, and pushing the upper edge backwards, and the lower forwards, and likewise in puncturing the cornea instead of the sclerotic; the best plan is that recommended by Scarpa.

The after-treatment is very simple, and consists in a single fold of linen, moistened in cold water, being applied to the eye. The patient is also to be put in a dark apartment, and narrowly watched, in order to see if inflammation supervenes; very frequently none arises.

SECTION 2. ON EXTRACTION OF THE CATARACT.

This operation was first performed towards the end of the seventeenth century; it was not, however, generally known till somewhat later, when it was brought into repute by Deville, who published the method of performing

it. Considerable improvements were subsequently made in the mode of performing it by Wenzel, who practised it with great dexterity, and astonishing success. There seems to be no necessity for preparing a patient for this operation, beyond taking care that his bowels be duly evacuated, and that he has not used any unusually stimulating diet previous to the operation. It would be highly improper to perform it, if the patient was at the time labouring under any other complaint or morbid affection; means should be taken to remove any complaint of this kind before the operation is attempted. Beyond these precautions, however, no preparatory treatment will be necessary, though I am aware that much stress was formerly laid upon this point. Several instruments will be required for the performance of this operation, which is a more complicated one than couching.

In the first place, a cornea knife will be necessary; the knife used by Wenzel, was something like a bleeding lancet; the blade, however, was neither so long nor so broad, and the edges were straight. Ware's knife was an improvement on Wenzel's; it is much less spear-pointed; the edges are straight as in Wenzel's, but while the lower edge is cutting, the superior edge is only cutting towards the point. From the point towards the handle there was a gradual increase in the size of the knife, a circumstance upon which Ware particularly insisted, in order that the knife, on being carried onwards, might always follow up the opening, so as to prevent the escape of the aqueous humour.

Wenzel's knife, however, and Ware's improvement upon it, are greatly inferior to the knife contrived by

Beer, the celebrated oculist of Vienna. This knife is very different in shape; the upper edge is quite straight, while the lower edge is made straight and oblique; the whole of the lower edge is cutting; the upper edge is cutting towards the point, and the size is accurately increased from the point towards the handle, so as to fill up the opening, and prevent the escape of the aqueous humour. Beer's knife is preferable to either of the others, because there is a much greater extent of cutting surface, so that the section of the cornea is completed in a shorter time and in a safer manner; it is besides capable of being made with much greater accuracy.

A speculum was sometimes used in this operation, but it is not at all necessary; in fact, all specula are objectionable, as they are likely to produce undue pressure on the globe of the eye. The next instrument is a pair of curved scissors, in order to enlarge the opening made into the cornea, if it should not be of sufficient size to extract the cataract. A minute curved needle will be required, in order to scratch the capsule of the crystalline lens; a curette, or scoop, to remove any opaque fragments of the lens, and a pair of minute forceps, of which the best construction is that recommended by Beer. to extract any portions of opaque membrane from the capsule of the lens. These are the principal instruments required in this operation.

Let us next consider the mode of performing it. The position of the patient should be nearly the same as that in the operation for couching; he should be placed opposite a window, so as to admit a full, clear, but not too vivid light. It should not be a reflecting light, so that if

the sun should happen to shine, a north window should be chosen; the inner side of the eye towards the nose, where the point of the knife is to be carried through, should be well brightened. The patient should be seated in a low chair with a high back, his head resting against it, or firmly supported against the chest of an assistant. The operator should place himself behind the patient in a chair of sufficient height to enable him to plant his foot conveniently on a stool, and resting his elbow on the knee opposite to the eye to be operated upon, bring his hand towards it. The assistant should then place his hand behind the patient's head, and with the extremity of his fore-finger gently raise up the lid without making pressure on the globe. The operator then takes the knife in his right hand, if it be the left eye which is to be operated upon, and in his left if it be the right eye, in the same way as he would take a pencil between his fore-fingers and thumb, resting his little finger upon the malar bone.

The first thing which the operator then does is, to make what is called the punctuation of the cornea. He introduces the point of the instrument at the distance of half a line from the anterior junction of the cornea with the sclerotic coat, and passes it in a direction nearly parallel to the iris, and before it with a little obliquity, through the anterior chamber to the opposite or nasal side. In making the section of the cornea, the knife should be carried onwards, without any downward motion; and as soon as the section is completed, the lid should be allowed to drop over the fore part of the eye, to prevent the escape of a portion of vitreous humour. If there should

be any spasm of the part, or any unsteady motion of the patient, the operator waits till the eye is quiet, and then introduces the curved needle with a convexity under the flap of the cornea; and turning the point towards the fore part of the capsule, moves it upwards, and downwards, and laterally from side to side, making a sort of crucial incision. He then squeezes out the cataract by making gentle pressure on the globe above and below, until the lens is lifted from its bed, and passes through the opening of the cornea upon the cheek of the patient.

All that then remains to be done is to examine whether there are any opaque fragments of the lens left; if there are, they must be scooped out by the curette; if not, the upper lid is to be rubbed over the surface of the cornea. If there is any portion of opaque membrane remaining, it must be removed by the forceps, and in this way the operation will be completed.

Many untoward circumstances, however, frequently interfere with the success of this operation. In the first place, the section of the cornea may be too small; in which case the surgeon will either be unable to dislodge the cataract, or so much force will be required for that purpose as is likely to produce serious inflammation, and such a degree of disorganization as will destroy vision. The section through the cornea should be about nine-sixteenths of a line, or one-sixteenth more than half a line from its junction with the sclerotica; the point of the instrument is introduced a little below the transverse diameter of the eye, on one side, and should come out a little above it on the other. If it should appear when the section of the cornea is completed, that the opening

is not sufficiently large, do not hesitate to use the scissors, in order to make it large enough to admit the passage of the cataract.

The second untoward circumstance which occasionally interferes, is the premature escape of the aqueous humour, either from the unsteadiness of the operator, or from some defect in the knife. On the escape of the aqueous humour, the iris loses its support, and becomes prolapsed. When this happens, the way of preventing any mischief will be, not to continue the incision, but to rub the cornea with the point of your finger, by which the prolapsed iris will be stimulated to contract; and on this being removed out of the way, the operator may complete the incision. This is the expedient recommended by Wenzel and Ware, and it answers the purpose extremely well.

The third unfortunate circumstance which sometimes occurs is the loss of a portion of the vitreous humour, arising from some undue pressure on the globe of the eye by the operator or assistant, or from some spasm of the muscles of the eye, though the last cause seldom happens. Another way in which this accident sometimes occurs, is when the needle is injudiciously used too near the circumference of the lens, and the capsule of the vitreous humour is torn through; so that when you make pressure on the globe, instead of the cataract coming forward, a large portion of vitreous humour is protruded. In this case the operator should not attempt to force out the cataract; but should endeavour to entangle it as much as possible, so as to prevent the escape of the vitreous humour.

The loss of the vitreous humour is sometimes occasioned by the use of the curette, in consequence of the instrument passing through the back layer of the capsule. The curette should never be used when the pupil is at all obscured ; the field of the pupil should be perfectly distinct when that instrument is employed. The loss of a small portion of vitreous humour does not essentially interfere with the success of the operation ; indeed, it has been said, and perhaps justly, that the loss of a small portion is rather beneficial than otherwise. It would be an extremely dangerous experiment, however, to endeavour to force out only a certain quantity. The loss of a portion of this humour should not prevent the operator from completing the operation in the best possible way, by removing all the loose fragments of the opaque lens, and the different portions of opaque membrane or capsule.

Another unfortunate circumstance which sometimes happens, is the introduction of the cornea knife between the lamellæ of the cornea ; the consequence of which will be, that the section of the cornea will be very small and imperfect. There are various other circumstances which may interfere with the success of this operation, which need not be detailed. Dexterity in performing it can only be acquired by practice. Wenzel, perhaps, rather exceeded the mark, when he said that the student must poke out a hatful of eyes before he can hope to perform this operation with success ; but, undoubtedly, considerable practice is necessary to enable him to acquire dexterity in performing it. Whenever any unfortunate circumstance happens, the operator should be perfectly calm, cool, and

deliberate; close the eyelid; consider what is best to be done; and having made up his mind on that point, proceed with firmness and decision in the operation.

With respect to the after-treatment, the principal object will be, as far as possible, to prevent inflammation. A compress of fine linen or cambric, kept wet with cold water, should be applied to the eyes, or rather to the eye opposite that which has been operated upon; it should be fixed by means of a bandage, carried round the occiput, crossed in front, and pinned on the sides of the nightcap. The patient should be carried to bed after the operation; placed in the recumbent posture, with his head a little elevated, and the room should be darkened. He should be allowed nothing but barley-water, tea, or water-gruel, for the first few days; and if there should be any symptoms of inflammation, such as pain, a sensation as if there were some external body in the eye, accompanied with quickness of pulse, a quantity of blood should be immediately taken away from the arm.

It will be better not to disturb the bandage, or raise the lid to examine the eye, for at least three days, unless the patient should feel any considerable pain or irritation; for, in that case, it would be advisable to ascertain the cause by examining the eye. The patient should be kept in bed in the recumbent posture for five days, and not even be suffered to rise for the evacuation of his fæces; a bed-pan should be used for that purpose. At the end of that time he may get up to have his bed made. The best way of preventing irritation is carefully to avoid making any undue pressure on the globe of the eye.

Great care must be taken, in adjusting the bandage,

not to depress the lower lid, by which means the section of the cornea may be brought over, and the adaptation of the cut edges prevented. Loose eyelashes are sometimes a source of irritation, and it will be right to examine whether there are any such before the operation; if there should be any tendency to inversion of the lid, you may prevent the lid from rubbing against the surface of the globe by means of a bit of adhesive plaster fastened to the cheek. It has been already stated that to operate, if one eye is sound, is not advisable; neither is it right, if there should be a cataract in each eye, to operate on both at once, unless the patient should particularly desire it.

SECTION 3. ON THE OPERATION FOR PROCURING SOLUTION OF THE CATARACT.

The third operation is that for procuring solution of the cataract, which is particularly adapted to the cataracts of children. This renders it necessary to make some observations on congenital cataract. Children are not unfrequently either born with cataract, or with a disposition to cataract, which speedily makes it appearance. Indeed, it is not common to find an absolute opacity of the lens, or of the capsule containing it, at the birth of the child; the cataract usually makes its appearance within a few months, or at least within the first few years, from the birth of the child. In some instances there seems an hereditary predisposition to this disease, several children in the same family being affected with it. The nature of the cataract may be firm, soft, or fluid; and it may be lenticular or capsular, as in the adult.

By far the most common form, however, according to

Mr. Saunders, who has given particular attention to cataract in children, is the capsular. In general, he found the lens itself more or less absorbed, the anterior and posterior layers of the capsule being opaque and adhering. The appearance of the cataract is somewhat different from that in the adult; there is an opaque nucleus either at the centre or some part of the circumference, and the rest has an unequal opacity, or streaked reticulated appearance. Another circumstance peculiar to congenital cataract is the unsteadiness and constant motion of the eye, which it is not difficult to explain. The eye has never been accustomed to have its vision fixed by objects, unless, perhaps, very imperfectly, and consequently the will has never been in the habit of influencing the muscles which give direction to the globe of the eye. Hence its unsteady and constant motion.

It was formerly deemed advisable to defer the operation for cataract in children, but Mr. Saunders has introduced a mode of operating in these cases which may be resorted to at any age. This is certainly one of the greatest improvements which have been made in this branch of surgery, not only because vision is extremely important for the purposes of education, but because, if the operation be delayed, a very considerable time will elapse before the patient can acquire a command over the eye, in consequence of the want of voluntary influence over the muscles. Another and more forcible reason, why this operation should not be delayed, is, that it is an universal law in the economy of nature, that all parts which are not exercised lose more or less of power; and, consequently, the retina, from not being accustomed to receive

the impressions of light, loses a considerable portion of its power.

Mr. Saunders found that in many cases where this operation had been delayed, the patients retained no more power of vision than was sufficient to enable them to distinguish between light and darkness. The operation may in general be performed with a hope of success between the age of eighteen months and four years. Mr. Saunders's mode of operating is not confined to the cataracts of children; it may be employed also in the cataracts of adults, provided they are fluid, soft, or membranous cataracts.

This operation is not entirely new; in Mr. Pott's works, some instances are mentioned, where he performed a very similar operation. He tells you that, in cases where the cataract was too soft for depression, he sometimes lacerated the anterior layers of the capsule, so as to admit the aqueous humour and procure the solution of the cataract. Hey, Scarpa, and Ware, have performed similar operations. We are not, however, to consider those as the inventors of any practice who have merely employed it here and there, without stating any certain rules for its general applicability.

It is to Mr. Saunders that we are indebted for having shown the principle on which he performed this particular operation, its applicability to cataract in children, and to some cases of cataract in adults. He may, therefore, be justly considered as the inventor of this operation, and is entitled to our respect and admiration for the introduction of so material an improvement in this branch of surgery.

The operation is very simple; it consists merely in making an opening in the anterior layer of the capsule of the lens, breaking up more or less the texture of the cataract and admitting the aqueous humour, in which the cataract is dissolved, and by this means absorbed. It may be more properly called an operation for the absorption, than for the solution of the cataract, since absorption is the ultimate object of it. The instrument required is a needle, very similar to that employed in the operation for couching; the point, however, is somewhat different; its shoulders are made cutting. It will be right, before the operation, to use belladonna for the purpose of dilating the pupil, so that the cataract may be distinctly seen. A small quantity of the extract of belladonna, softened to the consistence of cream, may be introduced into the eye, or smeared round the lids.

In operating on the adult, the patient should be placed in the same position as in the operation for couching; children are better placed in the recumbent posture, with the head fixed on a pillow. Sometimes a speculum is required to steady the eye; Pellier's speculum is the best for this purpose. The needle may be introduced either in the same way as in the operation for couching, or else through the cornea. In the latter case there are two modes of operating, called the anterior and the posterior. In the former, the needle is introduced at the distance of half a line from the junction of the cornea with the sclerotica, carried parallel to the iris, and turned inwards, so as to break up a portion of the capsule of the lens. In the posterior operation, the needle is carried through the posterior chamber, a little behind the iris, and the texture

of the capsule is broken up in the same way, so as to admit the aqueous humour. If the cataract be fluid, it immediately mixes with the aqueous humour, and there will be no more trouble. As to the after-treatment, the principal object must be, as in the former cases, to prevent inflammation. It is better in this operation not to attempt to do too much at once; but rather to repeat it frequently, than to break up the texture too extensively at once.

SECTION 4. GENERAL REMARKS ON THE OPERATION FOR CATARACT.

Having described these different operations, it may be necessary to consider which of them it may be most expedient to adopt. It appears that in those cases which admit of the operation for solution, namely, fluid, soft, and most cases of membranous cataract, that operation is greatly preferable to any other. Soft, fluid, and membranous cataract cannot be depressed. It is true that the operation for extraction might be performed, but it is to be considered that the operation for solution is much more easy, and that it does very little injury to the eye.

In firm cataracts, where it is a matter of indifference whether the operation for depression or extraction should be performed, that for extraction, supposing it to be equally well performed, is undoubtedly preferable, because the disease is entirely removed by it. It is not always, however, a matter of indifference, for there are many cases in which it would be extremely imprudent to attempt the operation for extraction, as, for instance, in cases of adhesion of the iris to the cornea, or where the

cornea is very flat, and the anterior chamber necessarily small, or in cases of contraction of the pupil, myosis, or arcus senilis.

There are some cases in which the unsteadiness of the eye is so great, either from spasmodic motions to which the patient is subject, or from invincible fear or stupidity, that it will not be advisable to attempt the operation. These remarks are borne out by the case of a woman in St. Thomas's hospital, who had cataract in both eyes, and was operated on by Mr. Green. When the operation was proposed to her, she immediately consented; and, supposing that she would have sufficient resolution to go through with it, he sat down with perfect confidence to perform the operation for extraction. She no sooner, however, felt the pain—pain it can scarcely be called—the uneasiness rather, arising from the application of the instrument—than she could not keep her head at all steady, but threw herself into all sorts of postures. He succeeded however, but with great difficulty, in making a very indifferent section of the cornea, and in extracting the cataract from the eye. He was then induced to attempt the operation on the other eye; and if the patient was unsteady during the first operation, she was ten times more so during the second. The consequence was, that though he completed the section of the cornea in the second, he found he could not proceed without the risk of doing considerable injury to the part; and he thought it best to leave the cataract in its place.

Where there are no contra-indications to deter us from performing the operation for extraction, it is undoubtedly the most effectual operation, as it completely removes the

disease; but then it requires much more skill and dexterity than the operation of depression; and the want of sufficient skill is more likely to prove injurious to the patient. The operation for depression is extremely easy, but it has its disadvantages. Not unfrequently the cataract rises again, and it will be necessary to repeat the operation. If the cataract be depressed on the retina, the patient will experience constant pain, which sometimes terminates in amaurosis. It sometimes happens, after the operation for couching, that the patient is seized with vomiting, accompanied with acute pain. This has been supposed to be the consequence of wounding the ciliary nerves. Whether this opinion is well founded is doubtful, but it commonly happens, that when the operation is followed by vomiting, the cataract rises again.

No judicious surgeon will, indiscriminately, prefer one mode of operation to another; his opinion must be decided by the nature of each particular case. In general, where the nature of the cataract admits of it, the operation for solution is preferable. In cases where the operation for extraction is not contra-indicated, it will be preferable to that of depression, if the surgeon has had sufficient opportunities of acquiring dexterity; but if he has not been much in the habit of performing the operation, the operation for depression is the safer, though less effectual course.

SECTION 5. OPERATION FOR ARTIFICIAL PUPIL.

Where, from some defect of the cornea or iris, or the parts connected with them, there is no passage for the rays of light, the operation for artificial pupil is required,

which consists in making a section with a cutting needle through the iris, which, by the elasticity of its fibres, separates the edges, and makes a passage for the rays of light. Cheselden was the first surgeon who performed it. There are three modes of performing the operation:—1st, by a simple incision of the iris, technically called *corotomia;* 2dly, where a portion of the iris is cut away, which operation is called *corectomia;* 3dly, where the iris is turned away from its attachment to the ciliary ligament, which is called *coredialysis.*

The simple incision of the iris is seldom resorted to; the operation of excision of a part of the iris was recommended by Mr. Gibson, and is certainly the best when the case admits of it. Mr. Gibson's mode of performing it, is to make an incision with a knife, as near as possible to the iris, and then, making gentle pressure on the globe of the eye, so as to protrude the iris, to snip off a portion with a pair of scissors. If the iris was adherent, so that it could not be protruded, he hooked it forward with a little hook, and then snipped away a portion with the scissors.

The operation of separating a part of the iris from its attachment to the ciliary ligament may be performed with Scarpa's needle. The needle should be introduced on the outer side through the cornea, at the distance of two lines from its junction with the sclerotica, and carried across the anterior chamber parallel to the plane of the iris. The point is then to be directed through the iris towards the inner side, and then, carrying it backwards and outwards, the iris is to be detached from the ciliary ligament.

The excision of a portion of the iris is the preferable operation, but where the case does not admit of it, the

detachment of the iris from the ciliary ligament is the next best operation. It is impossible to lay down general rules for these operations here, for the cases are so infinitely varied, that much must, after all, be left to the discretion of the surgeon, who should adapt the nature of the operation to the circumstances of each particular case.

CHAPTER VII.

AFFECTIONS OF THE EYEBALL.

SECTION 1. ON FUNGUS HÆMATODES OF THE EYE.

THE first disease deserving of our attention is the fungus hæmatodes of the eye, malignant fungus, or as it is called by some, medullary sarcoma, a disease which soon proves fatal, unless an operation be early performed, and even then the chance of success is extremely doubtful. No age appears exempt from this complaint, but it more frequently attacks the young; and a large proportion of the cases occurs before twelve years of age.

SYMPTOMS OF FUNGUS HÆMATODES OF THE EYE.

The first circumstance which attracts the notice of the patient is the vision becoming impaired. On looking into the eye at the commencement of this complaint, you see opposite to the pupil, and deeply seated, an appearance like a mirror, resembling an opacity of the lens, from which it is difficult to distinguish it. If the progress of the disease be watched, it will be seen that this appear-

ance enlarges into a prominence, proceeding from the bottom of the eye towards the cornea, and as it reaches the lens, care must be taken that it is not mistaken for cataract. There is one appearance, however, at this stage, by which the one can be distinguished from the other; upon the opaque substance, or the retina, of which its covering consists, branches of the arteria centralis retinæ may be seen ramifying.

The other symptoms are loss of vision, and the iris remaining immoveable. As the prominence enlarges, the iris becomes protruded, and the cornea distended. The conjunctiva becomes inflamed, the eyelids vascular, and in a diseased state; and in process of time the cornea sloughs, an opening is formed, and a discharge of a ropy mucus first takes place.

The fungus does not always protrude through the cornea, but sometimes through the sclerotic, and then it has a purple, livid hue, and is covered by the conjunctiva. When the fungus increases in size, it assumes a dark red colour, its surface is unequal, and irregular; it bleeds at the slightest touch; the parts slough, and then there is a fetid, sanious discharge. During the progress of the complaint, the health becomes affected, the countenance puts on a sallow hue, and the patient wastes in flesh. This disease is accompanied, and generally preceded, by disorder of the digestive organs; the appetite is impaired; and there are present all the other marks of derangement of the general health. When the strength and health are broken up, the disease very soon comes to a termination. The close of the disease is preceded by hectic fever; as is that of most complaints from which the general

health has suffered much during their progress. In fungus of the eye, the rest is completely destroyed, there is an affection of the nervous system; and in children, convulsions come on, which terminate their existence. In all stages of the disease, there is a tendency to them, and they generally prove destructive to life.

If the appearances of the eye be examined, little difference will be found in them from those of fungus in any other part. There is a grumous appearance on the surface, and the fungus bears a striking resemblance to the medullary matter of the brain; not unlike cream to the sight. The appearances, however, vary in different forms of the complaint. No one texture of the eye is free from it. It frequently commences from the optic nerve, extends to the retina, sclerotic, and choroid coats; but, on examining a fungus of the eye, it would be difficult to say where it began, the disorganization is so complete; the retina is destroyed—the humours are absorbed—the choroid protrudes, and very little of the natural texture is left.

In some cases the greater part of the anterior chamber is filled with a dark substance, like the pigmentum nigrum. In some instances the disease extends along the optic nerve, which enlarges, becomes altered in texture—of a brown colour—and reaches the brain, which will also be affected by the disease. The only remedy in this disease is the extirpation of the eye, and this in the early stage. In most cases, the operation proves unsuccessful, in consequence of its not being performed sufficiently early, or before there is a disposition in the constitution to reproduce the disease.

SECTION 2. CANCER OF THE EYE.

By cancer of the eye is meant, not cancer of the globe of the eye, for it rarely or ever commences in it; but it begins in the appendages and conjunctiva, and then extends to the globe of the eye; its common seat is in the conjunctiva. Cancer of the eye at the onset resembles a warty tumour with an ulcer on its surface, which has exactly the same appearances as ulcers in other parts of the body; therefore it will not be necessary to describe them; it then extends not only to the globe of the eye, but to the palpebral lining, the lachrymal gland, the periosteum of the bones forming the orbit, and the antrum; in fact, the globe and its appendages become one entire mass of disease.

No good can be expected in the treatment of this complaint unless the cancer be early removed by the knife. In the progress of the disease the general health becomes broken up.

SECTION 3. MELANOSIS OF THE EYE.

The eye is sometimes affected with melanosis, when it is converted into a peculiar black texture, a substance of sooty blackness. Should this affection be confined to the globe of the eye; if the optic nerve is not involved in the disease; if there be no evidence of any internal organ being affected; it is, under these circumstances, advisable to give the patient a chance, by its removal. In many cases where it has been performed early, the operation has succeeded, and the life of the patient has been saved;

if the operation be not performed, the tendency of the complaint is to destroy life, and it will go on to its destruction.

SECTION 4. EXTIRPATION OF THE EYE.

Although this operation appears formidable, and is so to the patient, as it is a most painful one, yet it is not difficult of execution. The best mode of performing it is as follows :—The patient is to be placed in the sitting posture, or, at any rate, with the head elevated, and in order to steady the eye, or shift its position, if necessary, pass a needle, armed with a ligature, through the fore part of the globe of the eye, by which means it is easy to steady it, or move it from one side to the other. If the lids are contracted, or the eyeball is exceedingly large, it will be necessary to divide the outer angle, in order to facilitate the operation. An assistant raises the upper lid, and the operator then introduces a double-edged straight knife through the conjunctiva, and divides the cellular membrane as extensively as he can. He next cuts through the oblique muscles ; and having done this, he then divides the recti muscles and the optic nerve ; to complete this last step of the operation, a curved knife adapted for the purpose, is used, and the globe of the eye is thus easily extracted.

It seldom happens that any hemorrhage takes place which may not be stopped by dossils of lint. The lids are to be brought in apposition, a compress of linen is to be applied over the eye ; inflammation should be guarded against, and the patient should not be neglected ; for al-

though inflammation does not frequently supervene after the operation, yet it sometimes comes on, extends to the membranes of the brain, and proves fatal.

CHAPTER VIII.

ACCIDENTS TO THE EYE.

HAVING described the various affections of the eye, it remains now to notice certain accidents to which it is liable, such as the introduction of extraneous bodies, and wounds.

SECTION 1. REMOVAL OF EXTRANEOUS BODIES.

It is very common for various minute substances to pass between the eyelids, and to get in contact with the external surface of the globe, or to adhere to the internal surface of the eyelids; in both cases causing great pain and inconvenience by the mechanical friction produced by the various motions of the eye and eyelids. The situation of any extraneous body is immediately perceived, not only by direct sensation, but in consequence of the motion of the lids, which, by passing the part affected, increases the pain, and, if the foreign body be small and moveable, generally removes it from the surface of the eye, whilst, by its adhesion to the inside of the lid, it becomes a more constant source of irritation. The situation of the offending substance has great influence on the symptoms which follow. When the extraneous body is lodged on that part of the conjunctiva which lines the

tarsal cartilages, it is rubbed against the cornea by every motion of the lid; the sensation is acute, and the general inflammation of the conjunctiva, and in succession, of the cornea, is certain, unless the cause be removed. In nine cases out of ten, the foreign body is lodged under the upper eyelid, and the symptoms come on much more rapidly and severely, in consequence of its greater latitude of motion. In order to remove the foreign body, evert the upper eyelid, which may be done in the following manner: take the ciliary margin of the eyelid between your thumb and finger, draw the eyelid downwards and forwards away from the eye, and with the end of a probe make pressure against the upper part of the lid, then carry the ciliary margin backwards over the end of the probe, in this way the upper eyelid is everted, and the mucous lining exposed; on this surface the extraneous body will generally be found, and may be removed by the point of the probe. If the foreign body be on the lower eyelid, the examination will be attended with little difficulty.

Extraneous bodies sometimes rest on the surface of the cornea, and produce nearly the same inconvenience as if they were attached to the under surface of the upper eyelid, though not quite so great pain. If the impelling force be sufficient to cause the foreign body to adhere to the part against which it strikes, it generally penetrates the conjunctiva, and becomes imbedded in the substance of the cornea. If no assistance be obtained, the results of such a trivial accident may be fatal to the eye. There is never any difficulty in discovering a foreign body implanted in the cornea, and its immediate removal ought to be effected by a cataract needle in the following manner: get the

patient into a good light, separate the lids with your fingers, and direct the patient to look attentively and steadily at any object before the eye, then, having a clear view of the extraneous body, insert the point of the cataract needle below it and raise it from its situation.

SECTION 2. PENETRATING WOUNDS OF THE EYE.

Penetrating wounds of the globe are attended with great risk of serious inflammation. Even in the operation for cataract, where the least possible violence is inflicted, most violent inflammation frequently ensues: it is not surprising therefore that wounds, the result of considerable violence with coarse blunt instruments, attended with lacerations and contusions, occasion most serious inflammation of the eye, in many instances attended with destruction of its function. In all these cases strict antiphlogistic treatment, perfect rest to the eye, rest to the body, and low diet, are indispensable: this is the constitutional treatment in all cases of wounds penetrating the cornea or sclerotic. The local treatment will of course vary with the case.

In these cases it sometimes happens that blood is effused into the chambers: the mere presence of blood, is in itself of little moment; because it will be absorbed; but its presence in the chambers of the eye, shows that an injury has been offered to the internal part which is likely to prove serious in other respects. It induces congestion of the retina, and impairs the function of the organ in the same manner as a violent blow on the head will impair the functions of the sensorium: so that a blow on the eye, by producing congestion of the retina, may be the

cause of permanent and incurable amaurosis. Blows on the eye frequently also give rise to a separation of the iris from the ciliary ligament, in consequence of which two openings are found capable of transmitting light; the pupil however generally closes from inflammation, while the artificial opening remains. Sometimes, from injuries of the cornea and iris, displacement of the lens takes place. In such cases it is advisable to enlarge the opening and extract the lens, otherwise, it may produce suppuration and inflammation of the eyeball. In some cases the iris protrudes; if it be uninjured, it may sometimes be made to contract by the joint stimuli of light and friction; if this should fail, the protruded portion should be removed by the scissors, so as to offer as little obstacle as possible tc cicatrization.

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