The anatomy and physiology of the organ of hearing; with remarks on congenital deafness, the diseases of the ear, some imperfections of the organ of speech, and the proper treatment of these several affections / By David Tod.

THE ANATOMY AND PHYSIOLOGY OF THE ORGAN OF HEARING;

WITH

REMARKS ON CONGENITAL DEAFNESS, THE DISEASES OF THE EAR, SOME IMPERFECTIONS OF THE ORGAN OF SPEECH,

AND THE

PROPER TREATMENT OF THESE SEVERAL AFFECTIONS.

By DAVID TOD,

MEMBER OF THE ROYAL COLLEGE OF SURGEONS.

"Opinionum commenta delet dies; naturæ judicia confirmat."

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PREFACE.

The following pages were written a few years ago for my own amusement. They were never intended to be laid before the public. Finding, however, as I proceeded in my anatomical investigations, that many of the textures which I examined, differed materially from those described by the best authors, and at the same time gave rise to several physiological ideas of a somewhat novel nature, I began to think of publishing the result of my investigations. In pursuance of this resolution, I have lately revised everything I had written, comparing it with the works of the most eminent Anatomists and Physiologists*; and, in the hope of rendering my inquiries not only more complete, but also useful, I have added, in the form of an Essay, a few remarks on Congenital Deafness, on the Diseases of the Ear, and on some Imperfections of the Organ of Speech.

In my Anatomical descriptions, I have, to prevent repetitions, given a name to every part I noticed. Some of these names are the same as those already in common use: the others—though perhaps defective—are the best I could devise. On the other hand, although I have delineated a number of Parts not as yet, to my knowledge, noticed by any Anatomist, I have only mentioned those which I

* Du Verney, Valsalva, Cassebohn, Morgagni, Winslow, Haller, Cotunnius, Sœmmerring, Scarpa, Monro, E. Home, A. Cooper, Carlisle, Saunders, &c.

am able to demonstrate from Preparations in my possession.

The Physiological remarks have been composed with all the care required by the obscurity that veils the existence and nature of the functions on which they are grounded. From the whole I have deduced a few inferences concerning the derangements to which the different textures of the organ of hearing are liable.

In the treatment of these derangements,—believing them to be the effects, either of a perversion, or of the absence of some of the essential properties of life; and these properties themselves to depend on the healthy functions of the secreting system,—I have insisted on the necessity of endeavouring to excite, by general and local means, the various organs duly to perform their respective functions. In cases where such means fail to produce the desired effect, I have ventured a few suggestions on the employment of acoustic machinery.

I have closed the volume with a few observations on the imperfections of the Organ of Speech, and on the means which should be employed for their removal. From the intimate connexion which exists between the Ear and the Larynx, and from the great difficulty which has hitherto been experienced in the alleviation or removal of the imperfections affecting the latter, I found I could not complete this treatise without making a few remarks on the subject.

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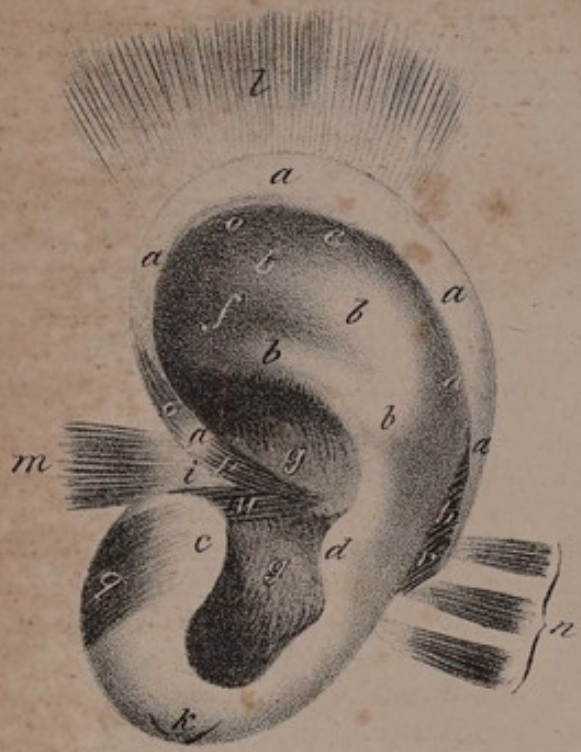
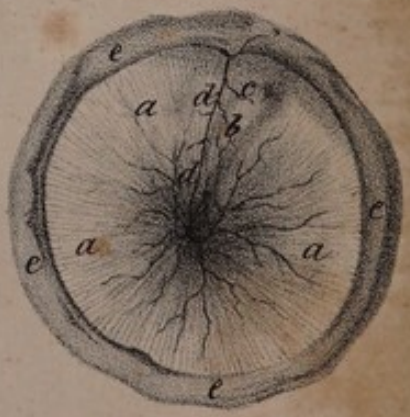


Fig. 2.

Fig. 3.

Fig. 4.



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d. —— Processus Longus.
E. Malleus.
e. —— Head.
f. —— Cervix.
g. —— Processus Brevis.
h. —— Manubrium.
i. k. —— Processus Gracilis.
l. Sinus Muscularis.
m. Processus Fallopii.
N. Stapes.
n. —— Crura.
o. —— Basis.

Fig. 5.

Fig. 6.

Fig. 8.

Fig. 9.

Fig. 7.

Fig. 10.

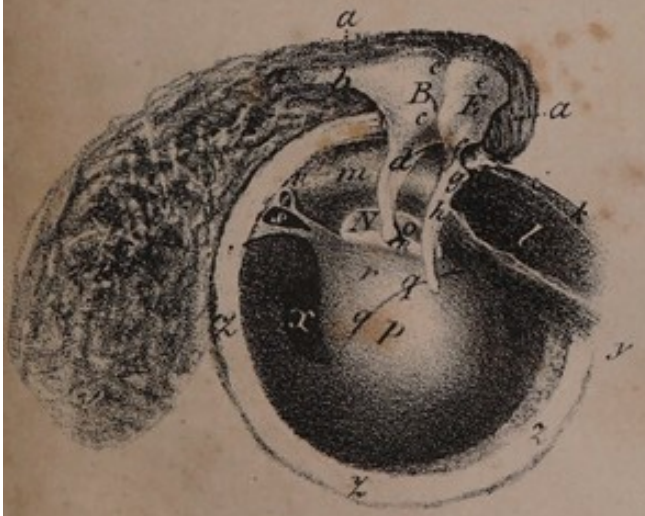
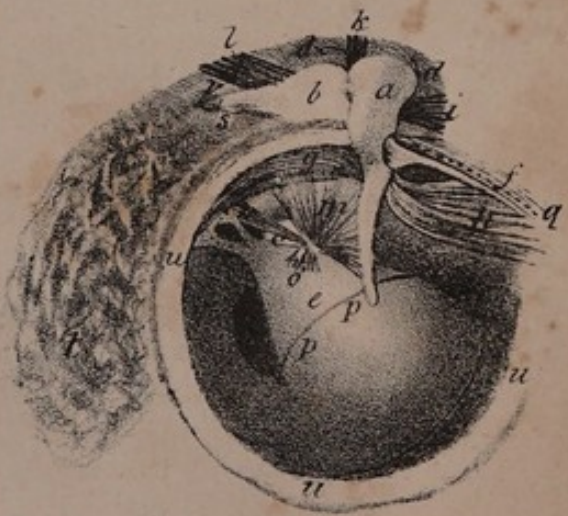


Fig. 11.



p. Promontory.
q. q. Sulcus Arteriosus.
r. Eminentia Pyramidalis.
s. Sinus Pyramidalis.
t. Iter ab Aquæductu Fallopii ad Tympanum.
u. Sulcus Stapedius.
v. v. Cellulæ Mastoideæ.
x. Fenestra Rotunda.
y. Canalis Eustachianus.
z. z. z. Part of the Os Annulare.

FIG. 11.

Apparatus Tympani in situ, (magnified).

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a. Malleus.
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g. h. i. } Posterior } Semicircular Canals.
k. l. m. } Inferior } Semicircular Canals.
n. Common Canal.
o. p. { Elliptical Cavities of the Inferior Semicircular Canal.
q. Elliptical Cavity of the Posterior Semicircular Canal.
r. Fenestra Rotunda.
s. s. t. t. u. } Cochlea.

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1. Elliptical Cavity of ditto.
c. c. Posterior Semicircular Canal.
2. Elliptical Cavity of ditto.
d. d. Inferior Semicircular Canal.
3. Ant^{r} { Elliptical Cavities of ditto.
4. Post^{r} { Elliptical Cavities of ditto.
e. Common Canal.
5. Orifice of ditto.
f. Situation of the Fenestra Rotunda.
6. 6. 6. 6. Scala Tympani.
7. 7. 7. 7. —— Vestibuli.
8. Cupola.

FIG. 14.

Cochlea (magnified).

1 2 $\frac{1}{2}$ } Turns or Gyrations.
a. b. c. } Scala Tympani.
d. e. f. } —— Vestibuli.
h. Modiolus.
k. Infundibulum.
l. Cupola.

ERRATUM.

Page 15, line 21, *for* Fenestra rotunda, *read* Membrana Fenestræ Rotundæ.

Fig. 12.

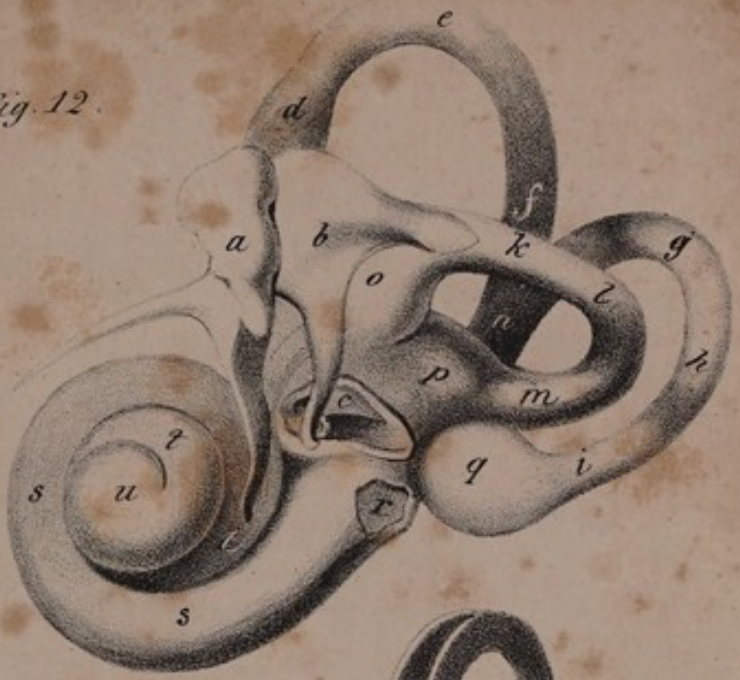

Fig. 13.

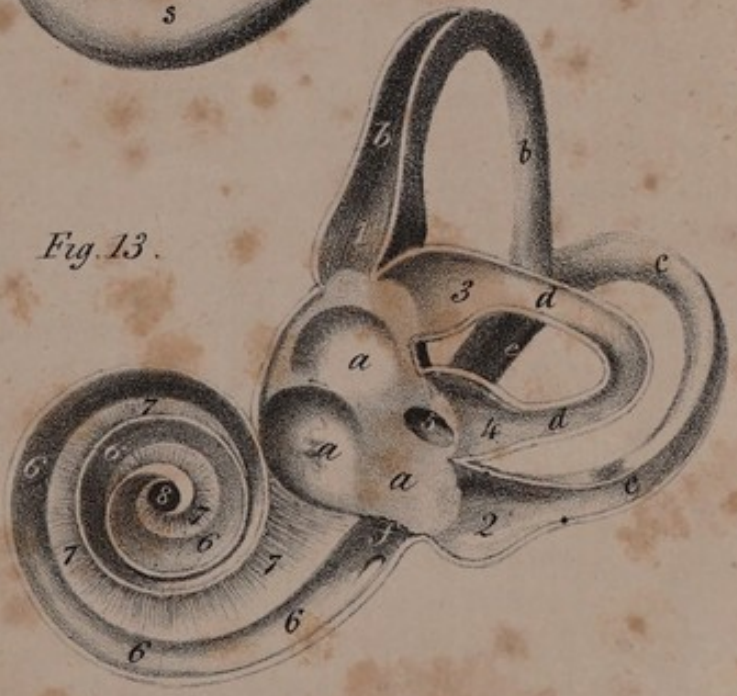

Fig. 14.

A. Ducôte's Lithog.r 70 St. Martins lane

A TREATISE

OF

THE ORGAN OF HEARING.

CHAPTER I.

ANATOMY OF THE EAR.

THE Ear, or Organ of Hearing, which I am about to describe, has generally been divided by anatomists into two portions,—an external, and an internal. The former comprehends all those parts which are situated without the membrane or drum of the Ear; and the latter, all those which are placed within it, and enveloped by the petrous portion of the temporal bone. This division, although arbitrary and defective, being generally employed in anatomical descriptions, I shall also make use of it in this treatise*.

The *External Portion*, or *Auricle*, is attached to the temporal bone by muscles, ligaments and common integuments. It is divided into a large superior and a small inferior portion, of which the former is called the *Ala*, or *Pinna*, and the latter *Lobus*: the two together form an irregular oval figure, somewhat resembling a muscle-shell.

The *Ala*, or *Pinna*, is chiefly composed of cartilage, and is modelled in such a manner as to form several eminences and cavities, which have received the following names.

* Were I disposed to make any alteration in the division of the Ear, I should be inclined to separate it into three parts; an external, middle, and internal,—and this as well from their relative positions, as from the peculiar functions which I conceive each has to perform.

The *Helix*, *Antihelix*, *Tragus*, *Antitragus*, *Cavitas Innominata*, *Scapha* or *Fossa Navicularis*, and the *Concha*.

The *Helix* is the large folded margin, or curved border, which commences at the posterior superior part of the Lobus, and from thence ascends and forms the margin or border which surrounds the upper part of the Ala, and subsequently descends, and terminates anteriorly, nearly opposite to its beginning, in a ridge which divides the cavity called the Concha into two unequal chambers.

The *Antihelix* is the large oblong eminence, which begins near the posterior extremity of the Helix, and from thence extends obliquely forwards and upwards, and terminates by dividing into two parts, a superior and an inferior, of which the latter assists in forming the superior part of the brim of the Concha.

The *Tragus* is the small eminence situated below the anterior extremity of the Helix. In advanced age it is generally covered with hairs.

The *Antitragus* is the small eminence situated a little below the posterior extremity of the Antihelix, and opposite to the Tragus.

The *Cavitas Innominata* is the curved depression which is situated between the Helix and Antihelix.

The *Scapha* or *Fossa Navicularis* is the small depression between the divisions of the anterior extremity of the Antihelix.

The *Concha* is the large cavity which is bounded above by the Antihelix, below by the Lobus, before by the Tragus, and behind by the Antitragus. It is divided by the anterior extremity of the Helix into a small superior and a large inferior chamber, of which the latter leads to the Meatus Auditorius Externus.

The *Lobus* is situated at the inferior part of the Ala. It is composed of cellular substance, with a small quantity of fat, and forms the inferior soft part of the Auricle.

On the posterior surface of the Auricle we observe a considerable eminence, called the *Dorsum of the Concha*.

The *Auricle* is covered with common integuments, which are extremely thin, and perforated in several parts by the excretory ducts of a number of small glands, that are situated beneath them.

On removing these integuments we observe the following *Fissures, Ligaments,* and *Muscles.*

A *Fissure* which separates the posterior extremities of the Helix and Antihelix from each other.

A *large Fissure* which separates the anterior extremity of the Helix from the Tragus, and enables the inferior chamber of the Concha to accommodate itself to the orifice of the Foramen Auditivum Externum.

Three or four small Fissures in the Concha, where it forms the inferior part of the orifice of the Meatus Auditorius Externus, which are placed a little transversely, but obliquely towards each other.

A *Ligament* which extends from the posterior extremity of the Helix to the Antitragus.

A *Ligament* which extends from the anterior extremity of the Helix to the Tragus.

A *Ligament,* called *Anticum Auriculæ,* which extends from the anterior superior part of the cartilaginous Meatus Auditorius Externus, to the root of the zygomatic process of the Os Temporale.

A *Ligament,* called *Posticum Auriculæ,* which extends from the root of the Dorsum Conchæ to that of the Mastoid Process.

The *Muscles of the Auricle* are of two kinds; one common to the Head and Auricle, the other proper to the latter.

The *Common Muscles* are three in number, of which one is situated above the Auricle—the *Attollens Auris;* one before it—the *Anterior Auris;* and one behind—the *Retrahens Auris.*

The *Attollens Auris* arises thin, broad and tendinous, from the tendon of the Occipito Frontalis, and from thence descends over the Fascia Temporalis, forming a thin fleshy slip, which becomes gradually narrower, and is

Inserted into the superior part of the Dorsum of the Concha near its root.

The *Anterior Auris* arises thin and membranous from the posterior part of the zygomatic process of the Os Temporale, and from thence extends backwards, and is

Inserted by a narrow tendon into the external surface of the anterior extremity of the Helix.

The *Retrahens Auris* arises sometimes by three, but more frequently by two distinct fleshy slips, from the posterior part of the mastoid process of the Os Temporale, and from thence extends forwards, and is

Inserted by small tendons into the Dorsum of the Concha near its root.

These three muscles, when they all act together, enlarge the cavity of the Concha, by drawing the parts into which they are inserted, towards their respective origins.

The *Proper Muscles* are seven in number,—the *Helicus Major* and *Helicus Minor*, *Tragicus*, *Antitragicus*, *Transversus Auris*, *Obliquus Auris*, and *Contractor Meatus**.

The *Helicus Major* arises fleshy from the anterior part of the Helix, where there is in general a small eminence a little above the Tragus, and from thence ascends about a quarter of an inch, and is

Inserted tendinous and fleshy into the surface of the anterior portion of the Helix.

Action. To draw the parts to which it is fixed towards each other.

The *Helicus Minor* arises fleshy from the margin of the Concha, just under the anterior extremity of the Helix, where it forms a part of the cartilaginous Meatus Auditorius Externus, and from thence ascends obliquely forwards, and is

Inserted fleshy into the Helix immediately below the origin of the Helicus Major.

* Anatomists have been accustomed to demonstrate only five muscles; but the two last, which I have added, are as obvious as any of the former.

Action. To draw the parts to which it is fixed towards each other, and thereby enlarge the superior chamber of the Concha a little.

The *Tragicus* arises fleshy from the anterior or outer surface of the root of the Tragus, and from thence passes outwards, and is

Inserted into its tip.

Action. To draw the tip of the Tragus a little forwards, and thereby enlarge the inferior chamber of the Concha.

The *Antitragicus* arises fleshy from the posterior surface of the Antitragus, and from the adjoining portion of the Dorsum Conchæ; and from thence ascends obliquely backwards, crossing the posterior fissure of the Auricle, and is

Inserted fleshy into the inner margin of the posterior portion of the Helix.

Action. To contract the posterior fissure of the Auricle.

The *Transversus Auris* arises tendinous and fleshy from the Dorsum of the Concha, and from thence ascends in a radiated manner like a fan, and is

Inserted fleshy into the Dorsum of the Cavitas Innominata.

Action. To draw the Cavitas Innominata downwards, and thereby render it more concave, and the Antihelix more prominent.

The *Obliquus Auris* arises tendinous from the Dorsum of the Concha, and from thence ascends, soon becomes fleshy, and is

Inserted fleshy into the Dorsum of the Scapha.

Action. To enlarge the Scapha.

The *Contractor Meatus* or *Trago-Helicus* arises fleshy from the superior margin of the cartilage which forms the Tragus, and from thence ascends obliquely inwards and backwards, and is

Inserted fleshy into the inferior surface of the anterior extremity of the Helix.

Action. To contract the anterior fissure of the Auri-

cle, and with it the orifice of the cartilaginous portion of the Meatus Auditorius Externus.

Besides these Muscles there are two or three others which are extremely small, and situated obliquely with respect to each other, between the margins of the small fissure in the inferior part of the Concha. They are tendinous at one attachment and fleshy at the other, and are for the purpose of contracting the fissure. There are also a great many muscular fibres, which have hitherto been described as *vestigia*, running in various directions over the different parts of the Auricle; so as to make it appear as if the various eminences and depressions, which exist on its surfaces, were produced by the action of muscular fibres.

Between these erratic fibres there are a number of small Glands like millet-seeds dispersed over the surface of the Auricle.

The nerves of the Auricle are very plentiful, and are larger and more numerous on its Dorsum, than on its anterior or external surface. They are chiefly derived from the Portio Dura. The arteries of the Auricle are derived from branches of the external Carotid, of which hereafter.

The *Meatus Auditorius Externus* is an oval canal of about three quarters of an inch in length, and, like the Foramen of the same name, is of different diameters in its different parts, being larger at its external than at its internal extremity, and narrower in the middle than at either.

It leads obliquely forwards and inwards, from the inferior chamber of the Concha; and in its course proceeds a little upwards, then downwards at its internal extremity, and terminates upon the surface of the Membrana Tympani. These curves, however, are very inconsiderable, for the internal extremity of the canal can be easily seen in a clear light, on drawing the Auricle a little backwards.

The *Meatus Externus* is composed partly of bone and

partly of cartilage. Its external portion is formed of a continuation of the inferior chamber of the Concha; its internal is osseous, and the larger of the two.

It is lined with a continuation of the common integuments, which, like those covering the Auricle, are extremely thin, and perforated by the orifices of innumerable small excretory ducts.

Between this lining and the other textures there are a number of small glands of a yellowish colour, called *Glandulæ Ceruminosæ*, imbedded in cellular substance. These glands secrete the yellowish viscid matter, called cerumen, or wax, which they transmit through their ducts for the lubrication of the canal, and for the diffusion of a gentle moisture over the surface of the Membrana Tympani; thereby rendering the stimulating nature of the sonorous impulses less harsh, and the membrane at the same time more sensible to their influence.

At the orifice of the Meatus Externus there are a number of short hairs, called *Pili Auriculares*, which project across it to prevent dust, insects, &c. from entering and irritating the canal.

In the *Fœtus* the Meatus Externus is wholly cartilaginous, and adheres chiefly to the Os Annulare.

The *Auricle* and *Meatus Externus* are supplied with blood from the temporal and auricular branches of the external Carotid Artery; and their nerves are derived partly from the third branch of the Par Trigeminum, but chiefly, as already stated, from the Portio Dura, though they have likewise branches from the first and second cervicals.

The *Membrana Tympani*, which separates the external from the internal portion of the Ear, is nearly of a circular form in the adult, and of an irregular oval in the child, with its short diameter placed somewhat transversely and obliquely.

It is composed of two laminæ, or membranes, an external and an internal; of a muscle, and a number of blood-vessels, nerves and absorbents.

The *External Lamina* is merely a continuation of the cuticle which lines the Meatus Externus. It is extremely thin and delicate, and can be readily demonstrated by maceration or boiling.

The *Internal Lamina* is a continuation of the membrane which lines the cavity of the Tympanum, called the *Membrana Propria Tympani*. It is firmly fixed to the internal margin of the groove of the Os Annulare, and to the whole length of the Manubrium Mallei.

The *Muscle* which has been named *Musculus Tympani** arises from the groove of the Os Annulare, and from thence runs obliquely inwards like radii from a circumference towards a centre, between the external and the internal lamina, and is

Inserted into the apex and whole length of the external surface of the Manubrium, and into the surface of the Processus Brevis of the Malleus.

Action. To draw the parts into which it is inserted according to the direction of its fibres: those which are fixed to the Manubrium draw it outwards in various directions, and those which are attached to the Processus Brevis draw it upwards and inwards.

The *Musculus Tympani* is a beautiful semitransparent muscle, composed of a very thin and delicate fasciculus of fibres, connected to its coverings by cellular substance.

It is extremely vascular, being replete with blood-vessels, which inosculate freely with each other. These are derived chiefly from the auricular, and partly from the temporal branches of the external carotid artery. The principal branch arises from the auricular, and runs down, in a parallel direction, close to the posterior margin of the Manubrium Mallei towards its apex; and in its course gives off numerous branches, which run outwards in a tor-

* This muscle was discovered some years ago by Sir E. Home, first in the Membrana Tympani of the elephant, and next in that belonging to man. I have several preparations in which it is very apparent.

tuous manner, inosculating freely with each other, and with those which run inwards from the circumference of the muscle.

It is also evidently well supplied with nerves; for when it is in a state of inflammation, it becomes very painful. The existence of its absorbents is proclaimed by its being occasionally the seat of ulceration.

In the *Fœtus*, the *Membrana Tympani* is of a peculiar texture; for round its circumference, and on each side of the Manubrium Mallei it is a little more opake, and also thicker than in the other parts, so that a beautiful semitransparent crescent is left between these, surrounded with a semiopake border: its external surface is, further, covered with a thin membranous lamina, which secretes a thick viscid matter, of a whitish colour, to defend it from the Liquor Amnii. This lamina and its secretion are gradually removed soon after birth by a process of nature.

The *Membrana Tympani*, during the fœtal stage of life, is also relaxed, and its muscle has no contractile power; but after birth, and as the child advances in age, it soon becomes very tense, from the Os Annulare becoming firmly incorporated with the Os Temporale, and from the action of its muscle, which is attached, as already stated, to the Manubrium and Processus Brevis of the Malleus, which are placed in such a manner as to make each of its surfaces both concave and convex.

The external surface of the Membrana Tympani is concave towards the Meatus through about seven eighths of its circumference, and along the whole length of the Manubrium Mallei, from near the shoulder to the apex, where the concavity is deepest. It is convex in the remaining eighth of its circumference to the shoulder of the Malleus, called Processus Brevis, which seems to press it outwards.

Although the Meatus Auditorius Externus is of an oval form, the Membrana Tympani is nearly circular, in consequence of the Os Annulare being placed a little obliquely, its superior part being turned a little outwards, and

its inferior and anterior a little inwards. Hence the superior surface of the Meatus is a little shorter than the inferior.

The *Membrana Tympani* forms a complete impervious septum; and from its extremely delicate and sensible texture, tension, concave and convex obliquity, it is rendered capable of being stimulated by a very small impulse of sound, and of being moved, by the muscles of the Cavitas Tympani, with the utmost facility. It also prevents all extraneous matter, as well as sonorous pulses transmitted by the air, from irritating the Cavitas Tympani.

The *Internal Portion of the Ear*, like the external, has been divided by anatomists into two parts; one called the *Tympanum*, the other the *Labyrinth*.

The *Tympanum* is an irregular oblong cavity of about half an inch in width, bounded anteriorly by the posterior extremity of the Eustachian Tube; posteriorly by the orifices of the Mastoid Cells; externally, by the Membrana Tympani; and internally by an osseous septum, called *Septum Tympani*, which separates it from the Labyrinth. It contains several small bones, muscles, ligaments, vessels and nerves.

The *Septum Tympani* has a very irregular surface, forming several eminences and cavities, of which the following are the most remarkable.

An *Eminence* called the *Promontory*, placed almost directly opposite to the centre of the Foramen Auditivum Externum, with its base facing obliquely forwards and downwards, below the extremity of the Eustachian Tube, and giving off from its opposite side a process of a pyramidal figure, called *Eminentia Pyramidalis Tympani*.

The *Eminentia Pyramidalis* extends obliquely backwards and upwards, is about the eighth of an inch in length, and terminates in a point opposite to a small cavity, called by Winslow, *Sinus Pyramidalis*.

Between the *Promontory* and *Eminentia Pyramidalis* is a small Sulcus, called *Sulcus Arteriosus*, which separates the one from the other, and defines the basis of the Eminentia.

The *Sulcus Arteriosus* is the continuation of a canal which runs through the bone from the anterior internal margin of the Fossa Jugularis of the Os Temporale.

Above the superior margin of the Pyramid is a semicircular Foramen, called *Foramen Ovale*, with its basis placed transversely and immediately above it.

This Foramen leads directly inwards, and in its course becomes gradually narrower, till at last it terminates in a defined margin, which projects a little into a cavity called the *Vestibulum*.

Below the inferior margin of the Pyramid, which is, in general, a little curved, is a Fossa leading obliquely forwards and inwards to a curvilinear triangular hole, called *Foramen Rotundum*.

Above the posterior part of the Sinus Pyramidalis is a very small circular hole, with a smooth margin, projecting into the cavity of the Tympanum, and giving off two slender processes, of which one ascends obliquely backwards, and terminates below the orifices of the Mastoid Cells, while the other descends obliquely forwards, and terminates upon the superior margin of the apex of the Pyramid.

This Foramen faces obliquely forwards and upwards, and is the orifice of a canal, called *Iter ab Aquæductu Fallopii ad Tympanum*, which runs obliquely downwards and backwards, in the space below and between the posterior and inferior semicircular canals, and joins the Aquæductus Fallopii about a quarter of an inch distant from the Foramen Stylo-Mastoideum.

Above the *Processus Posterior* is a small cavity called *Sulcus Stapedius*. This is largest in the Fœtus.

A little above the *Foramen Ovale* is a rough ridge, extending first obliquely upwards and forwards from the orifice of the *Iter ab Aquæductu Fallopii ad Tympanum*,

and then horizontally forwards to an acute point above the anterior part of the *Foramen Ovale*. This is the *Processus Fallopii*.

Above the *Sulcus Stapedius*, and the posterior part of the *Processus Fallopii*, are several Foramina, called *Foramina Mastoidea*.

Leading downwards and backwards from the *Foramina Mastoidea*, are a number of cells, representing a honeycomb, called *Cellulæ Mastoideæ*.

Before the anterior extremity of the *Processus Fallopii* is a rough cavity extending obliquely forwards and downwards, and terminating above the extremity of the Eustachian Tube, on the outer surface of the Pars Petrosa. This cavity is generally separated from the Eustachian Tube by a thin Osseous Septum, and is called *Sinus Muscularis*.

Facing the superior and anterior part of the *Sinus Muscularis*, is a small groove extending from the margin of the *Os Annulare* to the *Fissura Glaseri*, called *Canalis Anterior*.

Above the *Processus Fallopii* and the posterior half of the *Sinus Muscularis*, is a large rough oblong cavity with its longest diameter extending posteriorly, called *Fossa Navicularis*.

In the posterior superior part of the *Cavitas Tympani*, and close to the inner surface of the *Os Annulare*, is a long narrow semilunar depression, called *Sulcus Semilunaris*.

Below the *Sinus Muscularis*, and a little above and before the basis of the *Promontory*, is the termination of the posterior extremity of the *Canalis Eustachianus*.

The Use of these Parts.

The *Promontory* points out the situation of the passage which leads from the Tympanum to the Cochlea, called *Scala Tympani*.

The *Eminentia Pyramidalis Tympani* points out the situation of the orifice of a canal which runs from the Vestibulum to the Cochlea, called *Scala Vestibuli*.

The *Sinus Pyramidalis* separates the apex of the Pyramid from the orifice of the *Iter ab Aquæductu Fallopii ad Tympanum.*

The *Sulcus Arteriosus* receives the continued trunk of the *Ramus Septi Tympani Arteriæ Cerebralis.*

The *Foramen Ovale* receives the basis of a small bone called the *Stapes,* and its internal margin gives attachment to a very delicate membrane (called *Membrana Fenestræ Ovalis*), which closes the Foramen and separates one cavity from the other. This membrane is composed of a portion of the *Dura Mater,* which forms the Periosteum to the Labyrinth; it is convex towards the Vestibulum, and concave towards the Tympanum.

The *Foramen Rotundum* is the orifice of the canal called *Scala Tympani;* and in the recent subject gives attachment round its inner margin to a delicate membrane, called *Membrana Fenestræ Rotundæ.* This membrane is composed of two Laminæ, an external and an internal, of which the former is a portion of the *Membrana Propria Tympani,* and the latter of the *Dura Mater.* Its surface next the Tympanum is a little concave, and faces obliquely outwards and backwards, and a little downwards. It completely fills the Foramen, and separates the Tympanum from the Cochlea.

The *Iter ab Aquæductu Fallopii ad Tympanum* gives passage to a small nerve, artery, and vein, from the Aquæductus Fallopii to the Tympanum. The nerve is called the *Chorda Tympani,* and the artery, the *Ramusculus Stylo-Mastoideus è Ramo Auriculare Arteriæ Carotidæ Externæ.*

The *Sulcus Stapedius* gives origin to the *Stapedius Posterior* muscle.

The *Processus Fallopii* points out the situation and course of the *Aquæductus Fallopii.*

The *Cellulæ Mastoideæ* enlarge the cavity of the Tympanum, and probably render the hearing more acute.

The *Sinus Muscularis* gives origin to the greater part of the *Internus Manubrii Mallei* muscle.

The *Canalis Anterior* receives the *Processus Gracilis of the Malleus*, gives exit to the *Nervus Chorda Tympani*, entrance to the *Anterior Mallei* muscle, and a small artery (a branch of the Temporalis Superficialis) to the Tympanum.

The *Fossa Navicularis* receives the *head of the Malleus, the body and short process of the Incus*, gives origin and lodgement to the *Anterior Capitis Mallei, Superior Capitis Mallei*, and *Obliquus Incudis Externus Posterior* muscles, and attachment to the *external and internal Broad Ligaments* of the *Processus Brevis Incudis*, besides several other structures.

The *Sulcus Semilunaris* gives origin to the *Posterior Mallei* and a part of the *Triangularis Incudis* muscles.

The *Canalis Eustachianus* receives the posterior extremity of the Eustachian Tube.

The *Eustachian Tube* on leaving this canal runs obliquely forwards and inwards, in the Sulcus Eustachianus of the Os Sphenoidale, and terminates in the lateral part of the Fauces, just above and behind one of the wings of the Velum Pendulum Palati, and is about an inch and a half in length*.

It is of a conical figure; for its posterior extremity is narrow, and will scarcely admit the point of a surgeon's probe: but as it extends forward it gradually becomes wider, like a trumpet, and terminates by an oblique elliptic orifice with a thick prominent margin projecting into the Fauces, and large enough to admit a goosequill.

Its superior, internal, and the greater part of its external portions are formed of an elastic cartilaginous substance, which is of the same figure as the tube, for it is thick and strong at its faucial extremity, and becomes gradually smaller and thinner as it approaches the Tympanum; its remaining portion is composed of a thin mem-

* For a minute description of this tube, see Mr. Wathen's paper in the Philosophical Transactions, vol. xlix. p. 213, which he transcribed from Haller in Boerh. de Auditu, p. 378 not. è Physiologia Haller. de Auditu § 435. Valsalva, cap. ii. p. 32. idem, fig. xiv.

brane, the external surface of which gives origin to part of the Levator Palati muscle, and has a number of small glandular-looking bodies scattered upon it.

The surface of the Tube is covered with a continuation of the Membrane of the Fauces, which, on entering the Tympanum, expands and forms its lining, and is called *Membrana Propria Tympani.*

Its different textures are connected together by cellular substance, and each is supplied with blood-vessels, absorbents and nerves.

The *Membrana Propria Tympani* has been described as the Periosteum of the Cavitas Tympani; but it differs from that membrane in the following particulars :—it is thicker and more vascular than Periosteum, and it adheres firmly to the posterior extremity of the Eustachian Tube, the internal margin of the Os Annulare, the margins of the Fenestræ, Foramina, and origins of the Muscles, and loosely everywhere else : it also secretes a fluid which lubricates the cavity, to preserve the delicacy of its apparatus.

It lines the cavity of the Tympanum, forms the external lamina of the Fenestra Rotunda, the internal surface of the Membrana Tympani, covers the Chorda Tympani, the surfaces of the muscles of the Tympanum, and of the Ossicula Auditus.

It also assists in dividing the Cavitas Tympani into several compartments, excludes the Processus Gracilis and head of the Malleus and their muscles, and a portion of those of the Incus, and also the Mastoid Cells, from the cavity; it also connects the base of the Stapes to the Foramen Ovale; but does not form any part of the membrane of that opening.

It is more vascular in the earlier stages of life than in the adult, and is easily demonstrated in the Ear of many of the inferior animals, such as the dog, cat, &c.

The Bones of the Tympanum, called *Ossicula Auditus,* are three in number, viz. the *Malleus, Incus,* and *Stapes:* a fourth is added by some authors, called *Os Orbi-*

culare;* but this, in the human subject, is merely a process of the Incus, and not a distinct bone.

These bones are completely formed at birth; the two first are hollow, and the whole are destitute of marrow†.

The *Malleus* is situated externally, the *Stapes* internally, and the *Incus* somewhat between the two.

The STAPES is named from the resemblance it bears to a stirrup iron; it is divided into a *Head*, *Cervix*, *two Crura* or *Processes*, and a *Basis*; and when *in situ*, its *Head* is turned outwards, its *Basis* inwards, and its *Crura* are placed horizontally, with the longest posteriorly.

The *Head* is flat and of a circular form, and has on its external surface a small glenoid cavity with a defined margin, which, in the recent subject, is covered with cartilage, surrounded with a capsular ligament, and articulated with the *Button-like Process* of the *Processus Longus Incudis*, commonly called the *Os Orbiculare*.

The *Cervix*, which sustains the *Head*, is a thin hollow shell of bone, small and somewhat flattened, and has on its posterior surface a small depression for the insertion of the *Stapedius Posterior* muscle.

The *Crura* extend from the Cervix to the anterior and posterior margins of the Basis. The posterior is a little longer, and more curved than the anterior; and each forms on its inner surface a groove, which, with a corresponding groove in the Basis, gives attachment to a very thin membrane, called *Membrana Stapedis*. This membrane fills the opening of the Stapes, and is formed of a portion of the Membrana Propria Tympani.

The posterior surface of the *Posterior Crus* gives attachment to a thin membrane, having a little the appearance of a Fascia, given off from the *Stapedius Posterior* muscle.

* Sœmmerring disproves the existence of the Os Orbiculare; but in some of the inferior animals, such as the horse, ass, &c., it is very distinctly seen, and has apparently a muscle attached to it.

† Philosophical Transactions, vol. xcv. Part I. 1805.

The *Basis* is of a semicircular figure, corresponding to the shape and size of the Foramen Ovale, into which it is received and attached by a part of the Membrana Propria Tympani, and apparently also by a ligament which extends from the posterior surface of the Foramen to the small process which projects from its posterior margin. Its surface next the Membrane of the Fenestra is a little convex and smooth, and that next the Cavitas Tympani is a little concave.

The MALLEUS is named from the resemblance it is said to bear to a hammer; but it is more like a pistol than that instrument.

It is divided into *a Head*, *a Cervix*, *a Handle*, and *two Processes*, one extending from the Cervix, the other from the Handle. When the bone is *in situ*, its *Head* is turned obliquely upwards, inwards and a little backwards, into the anterior part of the *Fossa Navicularis*, and the cavity in the body of the Incus; its *Cervix* obliquely downwards and outwards towards the Meatus Auditorius Externus; its *Handle* obliquely downwards and inwards, so as to have the apex near the middle of the Membrana Tympani; its process from the Cervix, called *Processus Gracilis*, obliquely forwards and downwards, in the Canalis Anterior; and its process in the Handle, called *Processus Brevis*, obliquely outwards and upwards.

The *Head* is the largest and strongest portion of the bone, and is of an irregular oval figure, with a slight oblique depression on its posterior surface, which, in the recent subject, is covered with cartilage, surrounded with a capsular ligament, and articulated with the depression in the body of the Incus, forming a Ginglymoid Joint.

The *Cervix* is situated immediately below the Head in such a manner as to give the two the appearance of the butt end of a pistol.

The *Handle*, or *Manubrium*, forms an obtuse angle with the Head and Cervix, is of considerable length, and somewhat triangular, becoming gradually smaller and thinner

towards the apex, where it in general makes a slight curve forwards.

The *Processus Gracilis* extends from the anterior surface of the Cervix obliquely forwards and downwards, is longer than the Manubrium, but very slender, and is received into the external part of the Canalis Anterior, and gives insertion to the greater part of the Anterior Mallei Muscle.

The *Processus Brevis* is the small oblique surface on the external part of the root of the Manubrium. It projects a little over a portion of the Cervix.

In the recent subject, the Processus Brevis and the whole of the external surface of the Manubrium, are fixed to the Membrana Tympani, in such a manner as to make each side of the latter, as already stated, both concave and convex.

The *Processus Brevis* is fixed to the membrane near its margin where the Os Annulare is wanting, and there it bulges out so as to make the membrane convex externally, and concave internally.

The *Manubrium* descends from the Processus Brevis obliquely inwards, and terminates near the centre of the membrane (being a little anterior to it), so as to make it concave externally, and convex internally.

The INCUS is named from the resemblance it is said to bear to an anvil; but this comparison is as objectionable as that of the Malleus, for its figure is more like a knee-piece of a ship than any thing it has been compared to. It is divided into a *Body* and *two Processes*, one long, the other short; and when *in situ*, the *Body and Short Process* are situated in the Fossa Navicularis, the former contiguous to the head of the Malleus, and the latter extending obliquely backwards and downwards. The *Long Process* descends obliquely outwards, and nearly parallel but posterior to the Manubrium Mallei.

The *Body* is the middle and largest portion, and has on its anterior superior surface a *Depression* divided by an

oblique ridge into two parts, which, in the recent subject, are covered with cartilage, surrounded with a capsular ligament, and articulated with the depression in the head of the Malleus, already noticed.

The *Processus Brevis* extends from the body obliquely backwards and downwards, in the Fossa Navicularis, in such a manner as to have the whole of its anterior surface connected to the adjoining surface of the Fossa by numerous fibres, and its apex pointing obliquely downwards and backwards towards the middle of the posterior part of the Fossa, to which it is closely fixed by two broad ligaments.

The *Processus Longus* is a little longer, but much smaller than the Brevis: it descends from the Body, and forms nearly a right angle with the Brevis, and in its course is gently curved outwards, until it nearly reaches its apex, where it is turned a little inwards.

On the inner surface of its apex it gives off a small *Button-like Process* with a smooth surface, which, in the recent subject, is covered with cartilage, surrounded with a capsular ligament, and articulated with the head of the Stapes. This process is the *Os Orbiculare* of Authors.

The Posterior Internal Surface of the Processus Longus and the Inferior Internal of the Processus Brevis, form, by their union with the body, a curvature for the attachment of a broad, thin membrane.

The *Ossicula Auditus* have the following *Muscles**, *Membranes* and *Ligaments*, attached to them.

* Many will probably be inclined to doubt the existence of all the structures which I am about to describe, from their having escaped the notice of every one who has hitherto investigated the Anatomy of the Ear; but they can all be seen in the different preparations in my possession, and can be readily demonstrated in the ear of a child, when dissected in the way which I have recommended at the end of this anatomical description. That every structure or organ I describe as muscular is so in reality, is obvious, not only from its appearance in the recent bone, but also from the articulations of the bones admitting of their being moved with facility in the direction of the different muscles, and in no other; from their having spaces, which allow them

1. *Anterior Mallei**

Arises by a very small beginning from the extremity of the spinous process of the Os Sphenoidale, and from thence runs backwards, outwards and upwards, along the outer surface of the Eustachian Tube, and through the Fissura Glaseri and Canalis Anterior, from the surface of which it receives many fibres, and is

Inserted into the whole length of the Processus Gracilis, and anterior surface of the head of the Malleus, where there is a small eminence near its Cervix.

2. *Posterior Mallei*

Arises broad, thin and fleshy, from the Sulcus Semilunaris and parts above it near the groove of the Os Annulare, and from thence passes forwards and inwards, and is

to contract in the direction of their fibres; from their being found invariably present, when dissected in a proper manner; and from the parts of the Ossicula Auditus to which they are inserted, having eminences and depressions like the corresponding parts of other bones. But these are not the only reasons we have for considering the different parts which have been described as muscles, and not as ligaments or mere membranes; for if the bones were not moved by contractile organs in directions coinciding with their articulations, what would be the use of the articulations of the Ossicula Auditus, or of their being fixed so particularly to one another, and at the same time lying in so loose a manner in the Cavitas Tympani? Let us take for example the head of the Malleus, which is by far the largest and strongest, and perhaps the most important part of the bone;—what would be the use of that part, were it to lie in the Fossa Navicularis without having muscular textures pulling in those directions in which it is capable of being moved? Could it act with that nicety which we presume is necessary to convey the variety of phænomena to which the ear is sensible, otherwise than by the medium of delicate and sensitive muscles?

* I have named the muscles more from their situations than their apparent actions. The names already in use are very objectionable, particularly the Laxators and Tensors; for the Membrana Tympani is always kept tense, after the Os Annulare becomes amalgamated with the entire bone, by the action of its own muscular fibres, which are more powerful than the combined strength of all those belonging to the Cavitas Tympani.

Inserted into the posterior surface of the Manubrium Mallei below its Processus Brevis.

3. *Internus Manubrii Mallei*

Arises by a very small beginning from the posterior cartilaginous extremity of the Eustachian Tube, and broad and fleshy from the Sinus Muscularis. The fleshy fibres from these origins terminate in a slender round tendon, which runs directly outwards from the sharp osseous ridge at the termination of the anterior extremity of the Processus Fallopii, and is

Inserted into the inner surface of the Manubrium Mallei behind but a little below its Processus Brevis.

4. *Anterior Capitis Mallei*

Arises from that part of the outer surface of the Fossa Navicularis just before the head of the Malleus, and from thence runs obliquely backwards and inwards about the twelfth part of an inch, and is

Inserted into the depression in the anterior surface of the head of the Malleus.

5. *Superior Capitis Mallei**

Arises fleshy from that part of the superior surface of the Fossa Navicularis just above the head of the Malleus, where it is articulated with the body of the Incus, and from thence descends, and is

Inserted tendinous into the superior and inner part of the head of the Malleus, close to the margin of the articulating surface.

6. *Obliquus Incudis Externus Posterior*

Arises fleshy from the external surface of the Fossa Navicularis just before the beginning of the Mastoid Cells, and from thence descends obliquely forwards and inwards, and is

* This muscle is described by Sœmmerring as a ligament. He calls it Ligamentum Proprium Teres.—*SŒMMERRING, Icones Organi Auditus Humani,* tab. ii. fig. 20.

Inserted into the middle of the superior surface of the Processus Brevis Incudis.

7. *Triangularis Incudis**

Arises broad and thin from a part of the Sulcus Semilunaris on the inner side of the Posterior Mallei, and from the root, and sometimes from the whole length of the posterior surface of the Manubrium Mallei. From these origins the fleshy fibres run in a converging manner, the posterior obliquely forwards and inwards, the superior obliquely downwards and inwards, and the anterior obliquely downwards, backwards and inwards; and the whole are

Inserted broad and thin into almost the whole length of the outer surface of the Processus Longus Incudis, and the anterior surface of the Cervix of the Stapes.

8. *Stapedius Posterior* olim *Stapedius*

Arises fleshy from the Sulcus Stapedius, and from thence passes forwards, and a little upwards and outwards, in the form of a pyramid, and is

Inserted tendinous into the depression in the posterior surface of the Cervix of the Stapes, and membranous into the posterior surface of the Button-like Process of the Incus, and a small portion of its Long Process.

9. *Musculus* or *Structura Stapedius Inferior.*

This Muscle, or Structure, (for I have not as yet been able to discover muscular fibres in it sufficiently clear to warrant my calling them by that name, although it looks more like muscular texture than any other,) arises broad and thin from the middle of the outer surface of the Eminentia Pyramidalis, and from thence extends obliquely upwards and outwards in the form of a pyramid, and is

Inserted into the under surface of the Cervix and Crura of the Stapes.

There is another structure apparently muscular extend-

* This muscle is noticed by a Dr. W. Holder in the year 1668. Vide Philosophical Transactions, vol. iii. p. 666.

ing from the external surface of the Fossa Navicularis directly opposite to the head of the Malleus and body of the Incus, and fixed to those parts of the bones.

The *Membranes* are,

A broad, thin and very delicate membrane extending from the whole length of the outer surface of the body and Short Process of the Incus, directly outwards to the adjoining surface of the Fossa Navicularis.

A broad, thin and very delicate membrane, which extends from the inner surface of the curved margin which is formed by the union of the Long and Short Processes of the Incus, from the corresponding part of its Button-like Process, and from the superior surface of the Cervix of the Stapes and Membrana Stapedis, directly inwards to the adjoining surface of the Septum Tympani.

A broad thin membrane which extends from the inner surface of the head of the Malleus, and adjoining surface of the body of the Incus, directly inwards to the opposite surface of the Fossa Navicularis.

A broad thin membrane which extends from the surface of the Internus Manubrii Mallei as it runs towards its insertion, obliquely upwards and outwards to the surface of the Processus Gracilis and Cervix of the Malleus.

The *Ligaments* are,

A capsular Ligament which connects the articulating surface in the head of the Malleus to the corresponding surface in the body of the Incus.

A capsular Ligament which connects the articulating surface of the Button-like Process of the Incus to the corresponding surface in the head of the Stapes*.

A strong broad Ligament which connects the outer surface of the Processus Brevis Incudis at the apex to the outer surface of the Fossa Navicularis, close to the beginning of the Mastoid Cells.

A strong broad Ligament which connects the inner sur-

* When we dissect the cavity of the Tympanum by elevating the inferior part of the Os Annulare, we almost invariably rupture the capsular ligament of the Stapes, unless it be done with great care.

face of the Processus Brevis Incudis at the apex to the adjoining surface of the Fossa Navicularis.

These two broad Ligaments are each about the sixteenth part of an inch in length, and the external is situated immediately below and behind the Obliquus Incudis Externus Posterior Muscle.

These broad Ligaments, with the Processus Gracilis, form the pivots to the various motions of the Ossicula Auditus.

The Motions of the Ossicula Auditus and the probable Actions of their Muscles.

When we press the external surface of the head of the Malleus directly inwards, the body and short process of the Incus are also moved in the same direction, whilst the Malleus appears to move as if it was suspended by the Cervix like a Steelyard; for while its head is pressed inwards, its Manubrium and Processus Brevis are forced outwards, so as to cause that portion of the Membrana Tympani which is fixed to the former to be less concave, and that which is attached to the latter to be more convex externally. But these are not the only actions which we observe on pressing the head of the Malleus inwards; for whilst we are forcing its Manubrium and Processus Brevis outwards, we are, at the same time, drawing the Processus Longus Incudis and the Stapes in the same direction.

When we press the internal surface of the head of the Malleus directly outwards, we force its Manubrium and Processus Brevis directly inwards, and make the whole surface of the Membrana Tympani more concave externally, and at the same time force the Processus Longus Incudis and the Stapes directly inwards, so as to cause the whole surface of the base of the Stapes to press upon the membrane of the Fenestra Ovalis.

When we press the anterior surface of the head of the Malleus backwards, its Manubrium, together with the Processus Longus Incudis and Stapes, are forced forwards,

so as to cause that portion of the Membrana Tympani which is posterior to the Manubrium to be less, and the other portion anterior to it to be more concave than usual; and at the same time to cause the anterior half of the base of the Stapes to make a greater pressure on the membrane of the Fenestra Ovalis than its posterior half.

When we press the body of the Incus downwards and forwards, we force its Long Process and the Stapes, and also the Manubrium Mallei, directly backwards, and produce in the Membrana Tympani and Fenestra Ovalis actions the reverse of those stated in the preceding section.

When we press the body of the Incus directly downwards, we force the Manubrium Mallei inwards, and at the same time cause the inferior or straight margin of the base of the Stapes to produce a greater degree of pressure upon the membrane of the Fenestra Ovalis than its other portion. And when we press the Incus from the extremity of its Long Process directly upwards, we cause the semicircular margin of the base of the Stapes to make the greater pressure upon the membrane of the Foramen Ovale.

We also observe in every motion which the Ossicula Auditus make, or are capable of making, that the Chorda Tympani is moved along with them.

All these motions which we have described, and have produced by violence, are performed by the muscles of the Ossicula Auditus. For when we draw in the natural direction of the Anterior Mallei forwards, and in that of the Posterior Mallei backwards, at one and the same time, we force the Manubrium Mallei and its Processus Brevis directly outwards, and the remaining bones follow. When the Internus Manubrii Mallei contracts, which it does inwards, the Manubrium follows it, and the motions of the Incus and Stapes take the same course.

The Anterior Capitis Mallei draws the head of the Malleus forwards. The Superior draws it upwards and outwards. The Obliquus Incudis Externus Posterior draws the Incus and head of the Stapes obliquely upwards and backwards. The Triangularis Incudis draws the Proces-

sus Longus Incudis and the Manubrium Mallei in the direction of its fibres. The Stapedius Posterior draws the head of the Stapes and Processus Longus Incudis backwards and inwards; and the Stapedius Inferior (if muscular,) draws the Stapes downwards and inwards.

The Tympanum and its contents are supplied with blood from three arteries; namely, the Ramus Septi Tympani Arteriæ Cerebralis, which enters the Tympanum by a small Foramen at the margin of the Fossa Jugularis, and ramifies in the Sulcus Arteriosus of the Osseous Septum;—the Ramusculus Stylo-Mastoideus è Ramo Auriculare Arteriæ Carotidæ Externæ, which enters the Tympanum by the Iter ab Aquæductu Fallopii ad Tympanum, and ramifies in its muscles;—and the Ramusculus Articularis è Ramo Temporale Superficiale, which enters by the Fissura Glaseri: and its nerves are derived chiefly from the Chorda Tympani.

In the Fœtus the Cavitas Tympani is always filled with a fluid which preserves the delicacy of the different textures, and probably assists in sustaining them in their relative positions. After birth the fluid gradually disappears.

The Labyrinth.

The Labyrinth is situated on the inner side of the Septum Tympani, which, as already stated, separates it from the Tympanum.

It is divided by anatomists into three parts, viz. the *Vestibulum*, *Cochlea* and *Semicircular Canals;* and to these may be added an appendix, called the *Aquæductus Fallopii.*

The *Vestibulum* is situated on the inner side of the Fenestra Ovalis, between the Cochlea and Semicircular Canals, and is named from its forming a common hall, or porch to these cavities.

It is somewhat of an irregular curvilinear triangular

figure—in appearance resembling the body of a common padlock, and about the size of a decorticated grain of barley.

One of its *Angles* points obliquely downwards and inwards towards the Promontory of the Tympanum, and the others obliquely upwards and outwards in opposite angular directions.

The *Internal Angle* is the largest of the three, forming a large round cavity above the orifice of the Scala Vestibuli, and perforated by several Foraminulæ, called *Maculæ Cribrosæ*, which lead to the *Fossula Magna* of the *Foramen Auditivum Internum*.

The *External Angle* is the smallest, and has two conical cavities with oval margins opening into it. These cavities are the anterior extremities of the Superior and Inferior Semicircular Canals.

The *Posterior Angle* is formed by the termination of the common canal and by two conical cavities with circular margins, of which one is large, the other small; the former is the posterior extremity of the Inferior, and the latter the inferior extremity of the Posterior Semicircular Canals.

The *Inferior Surface* or *Floor of the Vestibulum* is oblique and hollow, and has the Foramen Ovale opening into its external, and the Scala Vestibuli into its internal portion. The latter forms an oval Sulcus on the inner side of the Foramen, and corresponds with the Eminentia Pyramidalis Tympani.

In the recent subject there are *six* openings into the Vestibulum, and in the skeleton there are two more*, besides a number of Foraminulæ, called Maculæ Cribrosæ, already noticed. In the recent state there are the five orifices of the Semicircular and Common Canals, and the orifice of the Scala Vestibuli; and in the skeleton the Foramen Ovale, and a Sulciform opening in the extremity of the Scala Vestibuli, above the Foramen Rotundum.

The *Semicircular Canals* extend from the superior and

* Valsalva enumerates twelve openings to the Vestibulum.

external part of the Vestibulum, and are three in number, a *Superior* or *Vertical*, a *Posterior* or *Oblique*, and an *Inferior* or *Horizontal*.

The *Superior* or *Vertical* is placed transversely across the Petrous Portion with its convex side upwards, and in its course is a little twisted. Its anterior extremity dilates, and forms a conical cavity with an oval margin, which, as already stated, terminates in the external angle of the Vestibulum, and its posterior unites with the superior extremity of the Posterior Canal, and forms with it a common one, of about a quarter of an inch in length, which terminates in the posterior angle of the Vestibulum without forming any dilatation.

The *Posterior* or *Oblique* is placed further back than the former, and is parallel to the length of the Petrous Portion, with its convex side obliquely backwards and outwards. Its superior extremity, as already stated, unites with the posterior of the Vertical, and its inferior dilates, and forms a conical cavity with a circular margin, which opens into the posterior angle of the Vestibulum, and is a little posterior to the Foramen Rotundum, as seen in the Cavitas Tympani.

This canal does not form the segment of so large a sphere as the former.

The *Inferior* or *Horizontal* is placed horizontally above the Aquæductus Fallopii, with its convex side outwards, and forms the segment of the smallest sphere of the three. Its anterior extremity dilates, and forms a conical cavity, with an oval margin immediately below the corresponding extremity of the Vertical Canal, and above the Foramen Ovale; and its posterior dilates, and forms a conical cavity (generally the largest of any,) with a circular margin, which terminates in the posterior angle of the Vestibulum, below the orifice of the common canal, and nearly opposite to the orifice of the Iter ab Aquæductu Fallopii ad Tympanum, only a little below it.

This is the only canal which has two conical cavities at its extremities.

Each of these canals is of an oval form, and large enough to contain a piece of packthread. They each constitute upwards of three-fourths of a circle. Their conical dilatations are called *Cavitates Ellipticæ.*

The *Cochlea* is situated obliquely at the anterior and internal part of the Vestibulum, in such a manner as to have its basis towards the bottom of the Foramen Auditivum Internum, and its apex nearly opposite to the entrance of the Eustachian Tube into the Cavitas Tympani, but a little above it.

Its figure resembles the shell of a garden snail, is broad at its Basis and narrow at its Apex, and forms *two Turns* or *Gyrations, and a little more than a half,* round *a Newel,* or *Central Pillar.*

The *First Turn* is next the Basis, and is about two-thirds larger and wider than the *Second,* which becomes suddenly smaller. The *Second Turn* is anterior to the First, and is about half larger and wider than the remaining portion, which also becomes suddenly smaller, and terminates in an apex or point called the *Cupola.*

The *First Turn* is not all of one diameter, for in its course it becomes progressively smaller: the same appearance is obvious in the Second, and their twistings account for the sudden smallness which takes place in the Turns.

The Turns are each divided by a *Spiral Septum* into two canals called *Scalæ,* from their supposed resemblance to a staircase.

This *Septum* is composed partly of bone and partly of membrane. The osseous portion is the smallest; it is placed next the central pillar, and called Septum Scalæ or Lamina Spiralis; the membranous is placed next the shell of the Cochlea, and called by Valsalva *Zona Cochleæ.* This last is only seen in the recent subject, and its apparent use is to assist in preserving the sentient motion of the *Aqua Labyrinthi.*

The *Septum Scalæ* commences a little from the basis, and winds round the central pillar until it nearly reaches

the apex, where it terminates in a Hamulus or hook-like process, and forms with the Zona Cochleæ a complete division between the two Scalæ.

The *Scalæ* are upon the same level, one anterior to the other, so that the Septum forms the anterior side of the one, and the posterior of the other.

The *Scala* next the basis leads to the Fenestra Rotunda, and is called *Scala Tympani;* the other opens into the inner part of the floor of the Vestibulum, immediately above the former, and is called *Scala Vestibuli.*

The *Scala Tympani* is larger than the Scala Vestibuli*; for the Septum Scalæ does not wind round the central pillar exactly in the middle between the Turns of the Cochlea. Both the Scala Tympani and Scala Vestibuli are of an irregular conical figure, being large at the Basis, and extremely small under the Cupola, beneath which they are said to communicate†; and this communication has been called by Cassebohm *Canalis Scalarum Communis.*

The *Central Pillar*, or *Newel*, which forms the middle of the Cochlea, extends from the Basis to the Apex, or Cupola, and consists of two distinct portions, of which one belongs to the First Turn, and the other to the Second and Half; the former is called the *Modiolus*, and the latter the *Infundibulum.*

The *Modiolus* is a large hollow cylindrical tube, and from having its external surface divided by the Septum Scalæ, resembles in some measure the appearance of two

* The reverse is stated by Authors.

† I have considerable doubt as to the correctness of this assertion; for the part is so minute, and so situated, as scarcely to admit of accurate dissection. I have frequently perforated the Fenestra Rotunda, and evacuated the fluid from the Scala Tympani, and then exposed the Vestibulum, and found its fluid entire. I have also reversed this experiment, by first evacuating the fluid from the Vestibulum, and then perforated the Fenestra Rotunda, and found that its fluid had not escaped. I have likewise evacuated all the fluids, and allowed the cavities to dry for three or four hours, and then poured a fluid into the Vestibulum, and found a communication established, evidently owing to the membranes having been lacerated in the drying.

sliding tubes of a telescope, with the external and largest next the Basis. It occupies about one-third of the cavity of the First Turn, is placed horizontally with one extremity pointing towards the bottom of the Foramen Auditivum Internum, and the other in an opposite direction; and is perforated in all parts by numerous small Foramina, one of which, near the centre of its anterior extremity, is larger than any other, and leads to the cavity of the Second portion.

The *Second portion*, improperly called the *Infundibulum*, like the First, is hollow; but its figure is quite different, and its substance extremely thin and very brittle. Its Axis is also different; for its Basis is not placed on the centre of the anterior extremity of the Modiolus, but a little towards its outer margin; and as it extends forwards it makes a slight turn upwards and inwards, and terminates beneath the Cupola.

Its figure is somewhat conical, being larger at its Basis than at its Apex*.

The Hollow in the middle of the Newel, or Central Pillar, together with the numerous Foramina in its substance, are for the transmission of vessels and nerves to the Scalæ of the Cochlea.

The *Aquæductus Fallopii*, which we have called the Appendix to the Labyrinth, is a small osseous canal, which begins at a Foramen, just large enough to admit a hog's bristle, in the bottom of the Fossula Parva of the Foramen Auditivum Internum, and from thence runs obliquely forwards and outwards for about the eighth part of an inch, where it is joined by a small but short canal which runs from the Foramen Innominatum. It then forms a curve

* Anatomists say that its figure is conical, and resembles a funnel, having its Apex common with that of the Modiolus, and its Base covered by the Apex of the Cochlea; but if we strip the Infundibulum of its Scalæ, we soon perceive its Apex to be under the Cupola.—Since writing the above I have seen a preparation in the Museum of the Royal College of Surgeons, London, which clearly sets all doubts on this subject at rest.

outwards, backwards and downwards, and runs in the substance of the Processus Fallopii, to terminate at the Foramen Stylo-Mastoideum. This canal is cylindrical, and about four times as large as the Foramen in the bottom of the Fossula Parva. In its course, after having quitted the Processus Fallopii, it is joined by the Iter ab Aquæductu Fallopii ad Tympanum, already noticed, page 11.

The Aqueduct of Fallopius gives passage to the Portio Dura or Nervus Communicans Faciei, and to the reflected filament of the Vidian Twig of the Superior Maxillary Branch of the Par Trigeminum. These nerves in their course send off a small branch, called Chorda Tympani, which passes through the Iter ab Aquæductu Fallopii ad Tympanum, along with the Ramusculus Stylo-Mastoideus è Ramo Auriculare Arteriæ Carotidæ Externæ, to the Cavitas Tympani.

The *Chorda Tympani* on entering the Cavitas Tympani ascends obliquely forwards, forming a gentle curve, and in its course passes under a part of the Triangularis Incudis Muscle, then across the inner surface of the Cervix Mallei, then round the inner or upper surface of the Insertion of the Internus Mallei and through the Canalis Anterior and Fissura Glaseri, and subsequently terminates between the Pterygoidei muscles by joining the Gustatory branch of the Inferior Maxillary portion of the Par Trigeminum.

Before it reaches the Cervix Mallei it passes over the Processus Longus Incudis, and gives off small Filaments to all the muscles of the Tympanum: it seems to be the nerve both of motion and of perception to these organs. One of its Filaments is much larger than the others, and runs obliquely forwards and downwards to the under surface of the Eustachian Tube, upon which it is distributed.

The *Portio Mollis* or *Nervus Acousticus* on entering the Foramen Auditivum Internum divides into three branches, and is invested with Processes of the Meninges of the Brain. One of these branches, with its coverings, runs through the Foramina in the Basis of the Cochlea into the Hollow of its Central Pillar, and through the Foraminulæ in its

laminæ, and is distributed upon the surface of the Scalæ Cochleæ. The other two branches, with their coverings, run through the Maculæ Cribrosæ to the Vestibulum and Semicircular Canals.

The *Meninges of the Brain*, which accompany the nerve, on entering the Labyrinth expand. The Dura Mater forms the Periosteum to its different cavities, the Zona Cochleæ, the Membrana Fenestræ Ovalis, and the internal lamina of the Membrana Fenestræ Rotundæ; and in all probability secretes a fluid to lubricate the adjacent surface of the Pia Mater, which is, in like manner, expanded to form a proper tunic to the nerve, which it covers on both surfaces.

The different *Fibrillæ* of the *Acoustic Nerve*, on entering the Labyrinth, unite and form a thin pulpy expansion between the two laminæ of the Pia Mater, in a manner similar to the Optic Nerve in forming the Retina of the Eye. This pulpy expansion is extremely soft and delicate, and covers the walls of the whole Labyrinth. From its different appearances in different places it is called by Scarpa,—in the Vestibulum the *Barbula*, in the Cochlea the *Zona Mollis*, and in the Elliptical Cavities of the Semicircular Canals the *Ampullæ*.

The *Pia Mater* which covers the nerve is highly vascular, but very thin and delicate; and that portion which lines its Internal Surface forms a hermetical Sac or Bag, called *Saccus Vestibuli**.

This Sac is filled with a thin transparent fluid, called

* There are two Sacs described by some authors, "one called Sacculus Vestibuli, which fills the hemispherical and semielliptical fovæ; the other, Alveus Communis Ductuum Semicircularum, which lies in the semielliptical fovæ, and receives the extremities of the Tubuli Membranacei, which lie in the Semicircular Canals. These two Sacculi in the Vestibulum lie together, and firmly adhere, but do not communicate, although they cannot be separated without tearing."—*See* Bell's Anatomy.

I have never been able to discover these Sacs in the recent subject; but when the parts become a little dry, there is evidently a division, which may be owing to the envelope of the nerve contracting in the drying, and quitting the surface of the Dura Mater, and thus giving it the appearance of two distinct bags.

Aqua Labyrinthi, which is secreted by its Arteries, and is of course constantly changed by the action of these and its absorbent vessels*.

The *Aqua Labyrinthi* is a living fluid, for it is never decomposed during life, and performs as important functions in the Labyrinth as the fluids in the Eye, or in the Ventricles of the Brain†.

The *Labyrinth* is supplied with blood from the Ramus Auditivus Internus Arteriæ Basilaris, which runs through the Foramen Auditivum Internum beneath the Auditory Nerve, until it arrives at the Fossula Magna et Parva; there it divides into innumerable small branches, which accompany those of the nerve, and are distributed in the substance of its coverings. It is also supplied with Absorbents to carry off the old or superfluous textures, and Aqua Labyrinthi‡. Its nerves are derived from the external Cornu of the Ganglion Gasseri of the Par Trigeminum.

Before we quit the Temporal Bone we may observe, that its periods of ossification are peculiar. In the Fœtus, at the third month of gestation, the Squamous Process, Os Annulare, the greater part of the Superior Semicircular Canal, a small portion of the Shell of the Cochlea, and of the Posterior and Inferior Semicircular Canals, are ossified; all the other parts are cartilaginous. In infancy, the Auditory and Mastoid Processes are wanting; in lieu of the former there is an imperfect osseous ring, called Os

* Dr. Ribes says that this fluid, in the Fœtus, is always bloody in appearance, and occupies all the extent of the cavities; and at a later period it is more transparent and less in quantity.—*Vide* London Medical and Physical Journal, vol. liii. p. 3.

I have invariably found the fluid transparent, and completely filling the cavities.

† See a brief account of some of M. Pinel's dissections, in the Medico-Chirurgical Review, vol. vii. p. 299.

‡ Cotunnius describes two Aqueducts which carry off the superfluous or old fluid; but I have never been able to discover them.

Annulare, which as the child advances in age gradually unites with, and becomes a portion of, the Adult Temporal Bone.

In children, the Os Annulare is easily separated from the Temporal Bone by maceration. The circle of the Os Annulare is never quite complete; the imperfect part corresponds with the root of the Zygomatic and Squamous Processes.

The Petrous Portion of the Temporal Bone is, in the adult, one of the hardest bones; in the fœtus and newborn child, however, it is one of the softest osseous structures in the Body.

Directions how to expose the Apparatus Tympani without doing the textures much injury.

Take the Temporal Bone of an Infant or Fœtus, and after injecting it, remove all the soft parts from its surface, keeping the Membrana Tympani entire; then introduce the point of a small scalpel between the Os Annulare and the Petrous Portion on the under surface, and separate the one gently from the other, so as to raise the two inferior thirds of the former about a quarter of an inch from the latter, and put a small piece of wood between them until the parts become quite dry. The different parts will then remain permanently *in situ*, only a little on the stretch. Again; take another Temporal Bone of the same age, and gradually remove the osseous shell which forms the upper part of the Fossa Navicularis and the inferior part of the Cavitas Tympani, and put the preparation aside to dry. Every texture will then appear *in situ*, and in a state of integrity. By repeating these dissections with slight alterations, every structure will be demonstrated in a variety of ways.

CHAPTER II.

PHYSIOLOGY OF THE EAR*.

HAVING taken a brief view of the various structures which enter into the composition of this curious and complicated organ, I shall now proceed to offer a few remarks on their respective uses. Nothing is more common than to say that we hear with our Ears, but it is far from being an easy matter to explain how we do hear. In discussing this subject, the first thing which merits consideration, is merely the effect of those external agents which have the power of exciting the Ear to hear. We hear from above, below, before, behind, from the right and from the left, and from all points. How do we become acquainted with the direction from whence sounds reach us? This is a question which every one who has investigated the œconomy of the Ear has been unable to answer, even plausibly; for all that has hitherto been said on the subject is equally unscientific and uninteresting†. What I have to say on the

* I fully intended to have made a few observations on the nature of the agent,—namely, *Life*,—which causes the production of all these textures, and subsequently gives them actions, before I ventured to make any remark on their functions: for the Ear, like our other organs of sense, is a passive machine,—a mere instrument designed to convey to the Sensorium notice of a particular effect, but unable to perform that office without the addition of a corresponding susceptibility. But after I had finished what I had to say on the subject, I found, as the phænomena of life in relation to the Ear comprised but a small part of the general subject, that I could not with propriety introduce a discussion so extensive, as a part of this particular treatise. I have therefore in the mean time suppressed this portion of my work, but with the hope of still being enabled to lay it before the public at some future time.

† As a specimen, we are told that Sound is conveyed to the Portio Mollis by the Auricle reflecting it to the Meatus Externus and Membrana Tympani; that from the latter it is conducted inwards by the

sense of hearing,—this important function of the animal œconomy,—will be in the following order. I shall first endeavour to explain the functions of the External portion of the Ear. And I shall then proceed to describe, in succession, the functions of the different structures which compose the Internal organ; taking notice, as I advance, of some of the opinions of others on certain textures and their offices, and endeavouring to point out such as seem to agree with facts, from such as do not.

In the formation of the Body it is universally allowed, that Nature has observed the same rule which she has followed through the whole range of her operations; viz. that she has made everything perfect, and nothing superfluous; and that to prevent her œconomy from being disturbed or destroyed by extraneous matter, she has placed every organ of essential importance out of danger, and at the same time established an intimate connexion between the organ and the agent with whose influence its actions are intended to associate. Now since this is the case, it is obvious that every texture belonging to an organ must be placed according to the scale of its importance, that the actions of one structure must harmonize with those of another, and that the aggregate must produce the effect intended or required by Nature. In the formation of the Ear we have, as already stated, an external appendage called the Auricle, curiously constructed, and conspicuously placed at the lateral part of the head, forming the external portion of the

Ossicula Auditus, by the Fenestræ, by the walls of the Tympanum and Labyrinth, which communicate the tremor directly to the pulpy substance of the nerve. That the organ of hearing is the same as a drum, an instrument which sounds when its pelt or head is struck with the drum-stick, the muscles of the Ossicula Auditus serving the purpose of the tightening cords, and the Eustachian Tube as the hole in its side. But how can this comparison be reconciled, when the one is the cause and the other the effect of Sound? A drum sounds from the effects of the drum-stick, and the Ear hears from the effect which that effect produces in certain parts of its machinery. The cause and the effect are totally distinct and different things, and yet they are by the above theory considered as one and the same.

Meatus Auditorius, and closely connected by a process of its superficial covering with the Membrana Tympani. This appendage, from being of an elastic nature,—from having muscles to act upon its various eminences and depressions, and a great number of nerves, blood-vessels, and glands, dispersed over its surface,—from being covered with a very thin membrane, and having an irregular concave and convex surface, must not only have the power of moving in different directions, and to certain degrees, but also be susceptible of some particular excitement*. From its forming the External portion of the Meatus Externus, it must have the power of dilating and contracting the orifice to a certain extent. Its connexion with the Membrana Tympani must also give it the power of producing a certain action in that membrane. And from its nerves, which are very large and numerous, being derived from the Portio Dura, it must have the power of exciting, through their connexion with the Chorda Tympani, certain effects in the Apparatus of the Tympanum, and, through their union with the Pes Anserinus, certain sympathies with the surface of the Head, Face, and Neck. From all these considerations, then, have we not reason to assign to the Auricle, notwithstanding all that has been said to the contrary, an office of some importance? We believe that we have: and in this opinion we are strengthened when we refer to the Inferior Animals. Do we not there find that the Auricle† is provided, of especial size &c., to those whose

* Some writers dispute the utility of the Auricle, and consider it as a mere ornamental appendage. And in support of their ideas, they affirm that horses which have their Ears cropt hear quite as well as those which have not. But how can they prove this? That horses which have their Ears cropt hear very well, no one can deny; but how can they prove that their hearing is not in the smallest degree deteriorated by this operation?

† In worms, insects, fishes, and reptiles, there is no Auricle or Meatus Externus. In birds there is a Meatus, which is chiefly cartilaginous. In the Cete quadrupeds the Meatus is long and winding, and in every other quadruped it is very large.—*Vide* Scarpa *de Auditu et Olfactu*, fol. Pav. 1760.

existence depends in some measure on the excellence of the sense of hearing? In Birds, the Auricle may be said to make its first appearance; but among these we find considerable varieties in the degree of its development. The Carnivorous have it much larger than the Graminivorous and Herbivorous; and among the former it is larger in those which go in quest of their prey during the night, than in those which procure their food during the day. In Quadrupeds the Auricle may be said to exist in its state of highest perfection, and to possess the greatest extent of motion; but among them we likewise observe great varieties in each of these respects. Thus in the Hare and Rabbit, the size and extent of motions of the Auricle are greater than in the Dog, Cat, Fox, &c. In the Elephant and Bullock its size is very inconsiderable in comparison with the magnitude of the animals: its motions also are comparatively limited. Nevertheless, we invariably find in all these animals that the size and motions of the Auricle, coincide with the importance of the Ear to the creature for the preservation of its life. The Hare and Rabbit appear to owe their safety as much to their acuteness of hearing as to their swiftness of foot; the Dog, Cat, Fox, &c. more to the acuteness of their nose and ears; and the Elephant and Bullock more to their size and physical strength. In all these animals the same kind of textures, and the same peculiarity in the distribution of the nerves and blood-vessels exist as in the human subject; and for these reasons we are inclined to think that the Auricle has been provided for a very important purpose.

Assuming what has just been stated to be correct, we have next to inquire what the nature of the office of the Auricle may be? This, of course, can only be ascertained by observing the actions of the different structures of the Body at large in the different states of health and disease, and subsequently comparing these actions with the effects which they seem to produce in the Ear as an organ of sense. For although we have reason to believe that the Auricle has been formed for a special purpose, yet the mere

investigation of its different textures does not enable us to discover what that purpose is. The first question that occurs concerning the use of the Auricle is, whether its functions are to be considered as essential, or as accidental or adventitious, to hearing? Essence and Accident are very ambiguous terms; but if we understand by the former that which makes anything what it is *per se*, I apprehend the question may be easily answered: for nothing, then, is more clear, than that the use of the Auricle must be held a matter of secondary importance; otherwise Nature would not have placed it where it is exposed to so many accidents, nor made so great a distinction among the different members of her family in its state of development; neither could it have been mutilated without producing effects of great moment on the sense of hearing, had it been a part essential to this function. In confirmation of this, we have only to compare the effects which are produced on the hearing of those animals whose Auriculæ have undergone the operation of cropping. The influence of this operation is so little, that the closest investigation does not enable us to discover the least change; and for this fact no other reason can be assigned, than that the functions of the Auricle are merely adventitious or accidental. The subject therefore of our inquiry contracts itself into a very small compass. We have only to learn what that is which can be called accidental, and the whole mystery which envelops the use of the Auricle is removed. Now we know by experience, that every accident to which a sonorous body is liable, is local. For whether that body be white or black, hot or cold, wet or dry, the effect which it produces on the Ear must invariably correspond with the nature of the properties which impinge against the sentient surface of the organ; and one of these properties must relate to the situation in which the sonorous body is placed, and consequently cannot be said to exist in it. Hence the cause of those animals whose hearing is extremely acute, and of great importance to their œconomy, having large and very moveable Auriculæ, and making extensive use of them

when endeavouring to discover the quarter from whence sounds proceed. Were it not for this provision of nature, many of the inferior animals would have been left without some of their most valuable endowments. The Dog, for example, when he loses the scent, but not the sound of his master, would never be able to find him out without this admirable provision. When so situated, we observe that he immediately elevates his head, shuts his mouth, erects his Auriculæ, and has their concave surfaces directed generally forwards. Then he may be considered as listening with the greatest attention, and in the very best position for that purpose; for by raising his head he becomes enabled to receive the anticipated effect with great facility; by shutting his mouth (his lower jaw having a perfect ginglymoid joint,) the Anterior Auris muscle of each Auricle becomes enabled to dilate the orifice of its corresponding Meatus Externus to the utmost extent; and by erecting his Auriculæ with their concavities directed forwards, he becomes enabled to collect all the properties of sounds, including, of course, those which relate to its locality. The same remarks are, with very little exception, applicable to the hare, rabbit, fox, cat, and indeed to every animal which makes extensive use of its Auriculæ.

But perhaps these comparisons will be considered as inapplicable to the Auricle in the human subject, because, among all the animals which have been mentioned, that appendage possesses extensive motion, and is occasionally employed for other purposes besides those which belong to the accidental properties of sound; whereas, in man, its motions are so inconsiderable as to be imperceptible to the eye of the closest observer. To this objection we may observe, that the accidental properties of sound are not of that importance to the œconomy of the Human Being, which they evidently are to inferior creatures; for man's existence and preservation depend more on the various attributes of the mind than on the functions of the ear, and therefore extensive motions in his Auriculæ are unneces-

sary. However, as all physiological doubts can only be removed by observation and experience, I shall insert the following experiments, which I am inclined to think are sufficiently conclusive to set this matter at rest.

Experiment 1.—I took a silver tube, and introduced it through the Meatus of one of my Ears, until I felt it touch the Membrana Tympani, having plugged the other Meatus with the point of one of my fingers. I then began to listen. The first thing perceived was, the total absence of the power of distinguishing the distance of sounds, and the quarter from whence they came; and the second was the pain which they produced, apparently from their harshness.

Experiment 2.—I took a cat, and cut the Auricle of one Ear completely out, and brought the margins of the skin together by suture, so as to obliterate the orifice of the Meatus Externus. After the animal recovered, nothing of any importance could be discovered in her œconomy for four or five weeks; but after that period she began to exhibit, occasionally, a considerable degree of alarm, and to run up and down the stairs several times a day, with great rapidity, until she became much exhausted. With these paroxysms of terror she was visited for nearly a month, when they entirely left her. Considering her symptoms to be very strange, I frequently watched her motions, in order to learn, if possible, the cause. When she awoke from sleep, I observed that she appeared as if confused and alarmed by the passing sounds; for she almost invariably started up suddenly, then by moving her remaining Auricle endeavoured to ascertain the direction of the sounds which appeared to disturb her, and afterwards ran off in great agitation. These symptoms, however, soon began to assume a milder character, and at last they entirely left her. After she got well, I clearly perceived that she could not discover the quarter from whence a sound came, with that facility which cats are known to possess; for she always moved her head, and also her

Auricle, in different directions, before she appeared aware of the quarter from whence any slight sound emanated.

From what we have now stated, there cannot, I think, exist a doubt as to the Auricle having been provided for the purpose of enabling animals to discover the accidental or local properties of sounds. But there are other offices which the Auricle must also perform; for if everything is, as we have reason to believe, of a compound nature, and has a form coinciding with its properties, it is very obvious that the irregular concave surfaces of the Auricle must endow it with the power of collecting all the sonorous properties, as well as of responding to those which we call local or accidental. Hence among those animals which make extensive use of their Auriculæ, we notice that they invariably turn their concave surfaces towards the sonorous body, and keep them fixed in that position as long as they are listening attentively: further, that they have the power of varying the figure of the Auricular surfaces according to circumstances. But the Human Auricle has, as already stated, very little motion, and therefore power of accommodating itself to these circumstances; for although it has an irregular concave surface leading to the Meatus Externus, its muscles have very limited powers over its motions. For this apparent defect, Nature has provided a substitute of a less complex, and of a more ornamental description; for when it is requisite to listen attentively to distant or obscure sounds, we instinctively open our mouth, and by this simple process enlarge the orifice of the Meatus Externus, through the medium of the Condyloid Processes of the lower jaw, which, from forming an imperfect or compound Ginglymoid Joint, draws the adjacent soft parts forwards and downwards, and thereby enable more sonorous properties to be conveyed to the surface of the Membrana Tympani.

The Auricle, therefore, has been provided for the purpose of congregating the sonorous properties, and also of producing, in the structures of the Tympanum, actions

coinciding apparently with the nature of the accidental or local properties of these sounds*.

As to the use of the Meatus Auditorius Externus, that appears so obvious as to require very little illustration. Were it not for this canal, the properties which have the power of exciting the organ of hearing, could not be conveyed to the surface of the Membrana Tympani in such volumes as to produce the intentions of nature. It has therefore been provided and formed for the purpose of allowing the sonorous properties to be transmitted in certain quantities to the surface of the Membrana Tympani; and from what was experienced in the experiment with the silver tube, we may also add, that it has the power of mellowing these properties in their progress, and consequently of preparing them for the surface of the Membrana Tympani.

The Membrana Tympani† which we now come to investigate, may be said to belong to neither the external nor the internal structures of the Ear, but to be common to both. For its outer surface is formed, as already stated, by a process of the superficial covering of the Auricle, and its inner by a part of the Membrana Propria Tympani: but from its being more intimately connected with the textures of the internal Ear than with those of the Auricle, it has always been considered as belonging to the former rather than to the latter. This membrane,—from being, like the Auricle, of a very remarkable figure, having on each of its surfaces a concavity and a convexity; from being composed of a variety of textures, one of which possesses the power of muscular motion; from being inti-

* Sir C. Bell says that the Ear has mechanical provisions for every change of sensation; but he has not attempted to explain what these provisions are.—*See* Bell's Anatomy.

† The Membrana Tympani is almost denied to insects, worms, fishes, many serpents, and some pedated reptiles which inhabit the water, as the Salamandra, &c.; but it is bestowed, and in an extensive degree, on other pedated reptiles, and is placed very superficially on the heads of those which live on land.—*Vide* Scarpa.

mately connected with the Handle and Short Process of the Malleus, and through that bone with the remainder of the Apparatus Tympani,—must, when brought into action, be capable of producing a variety of effects in all these parts. What these effects are, and how evolved, cannot, from the situation of the membrane, be ascertained by any direct observation and experiment; but as every effect is the product of motion, and every motion coincides with the properties of the agents which combine to produce it, we are inclined to think that they must come under the operation of certain laws of motion. And in this idea we are strengthened, when we reflect on the great law of nature,—that exercise is the chief source of improvement in all our faculties. Of this we have a clear illustration of what is called an ear for music. "Only the simplest and plainest compositions," says Dr. Blair, "are relished at first; use and practice extend our pleasure, teach us to relish finer melody, and by degrees enable us to enter into the intricate and compounded pleasures of harmony*." These pleasures can only be acquired by gradually accustoming the muscular textures of the Tympanum, and in particular those of its membrane, to such nice exertions. When, therefore, a musical sound is transmitted to the surface of the Membrana Tympani, an action coinciding with the nature of the former will be produced in the latter, (for every living texture is provided with its own sentient principle;) and that action will, in its turn, produce other actions in the different textures which are in its immediate neighbourhood; and consequently gradually accustom them, as they require strength, to a regular series or set of operations†.

We have stated, (page 9,) that the Membrana Tympani is a little oblique with respect to the Meatus Externus.

* *Vide* Blair's Lectures on Rhetoric. Lecture, *Taste*.

† Infants, when born, acquire, on breathing, their senses, with the exception of those of sight and hearing; for experience seems to leave no doubt that neither their eyes, although open, can be made sensible to luminous bodies, nor their ears to sound.

This obliquity, however, does not exist in man to so great a degree as in those animals which are very acute in their hearing, and which make extensive use of their Auriculæ; but it is still such as to make the surface of the Membrana Tympani much more extensive than it would have been, if disposed at right angles to the Meatus Externus. Now when we reflect that the more oblique a surface is, the greater is its power of repulsion and of motion, we can easily perceive the importance of this arrangement of the Membrana Tympani. In the formation of our Ear, no more obliquity may be said to exist in the Membrana Tympani than is necessary to our convenience; but among those animals whose hearing is essential to their preservation, nature has bestowed her favours with greater liberality, and at the same time taken the easiest method of adapting the means to the end.

The Membrana Tympani, then, is brought into action by the sonorous properties; and this action coincides with the nature of its œconomy. Its obliquity prevents the membrane from being injured by the actions which any violent impulses of these properties might have produced, and at the same time enables it to respond to the various sounds with the greatest facility.

The connexion of the Membrana Tympani with the Malleus enables it to convey the effects of its motions to the next station;—and this leads us to the consideration of the Ossicula Auditus*.

These small bones are the instruments by which the effects produced by the actions of the muscular textures of the Tympanum are conveyed to the Labyrinth. They are the most delicate and the most perfect osseous structures in the Body, and the least susceptible of disease. From their intimate connexion with the Membrana Tympani and Fenestra Ovalis, and with each other; from their

* There are no Ossicula Auditus in the organs of hearing in worms, insects, fishes, and some aquatic pedated reptiles; but they are present in all other reptiles, birds, and quadrupeds.—*Vide* Scarpa.

zigzag position and their numerous muscles; from the nature of their articulations; and from their being under the influence of a single nerve—the Chorda Tympani; we cannot doubt that they are capable of being moved in a variety of directions; that their motions are regular, and that these are productive of effects essential to the development of many phænomena appertaining to hearing. When, therefore, an action is produced in the Membrana Tympani, a certain effect must follow; the whole of the muscular structures of the Tympanum must be immediately called into action, and the Ossicula Auditus drawn into certain positions, each of which must produce a particular effect on the membrane of the Fenestra Ovalis. Every one of these actions and effects must harmonize with each other, and of course partake of the nature of that action which is produced in the Membrana Tympani. It is not by the action of any single part or texture of the Apparatus Tympani, that the effect required by nature for particular ends can be produced, but by the uniform co-operation of all the textures which enter into the composition of this Apparatus. Every part must, whilst it possesses its own percipient principle, perform, in its turn, its own particular function, before the required effect can be produced in the membrane of the Fenestra Ovalis. That these conclusions are just, is obvious, from the situation of the Apparatus of the Tympanum; from the absence of this apparatus being invariably attended with congenital deafness, (*vide* Cases,) and from the absence of the power of hearing during sleep.

It is unnecessary to discuss the various positions into which the Ossicula Auditus are capable of being drawn, by the actions of their muscles, further than what we have already stated (page 24); since the situation of these parts renders it impossible to discover either their mode of action or their relative effects. We may however observe, that we apprehend the ideas which have hitherto been entertained on this subject, are not only vague in themselves, but inapplicable to the whole phænomena of hearing.

The Chorda Tympani, which we have now to consider, is very superficial in the Cavitas Tympani, being scarcely covered by soft parts, and is apparently one of the most vascular nerves of motion in the body; and when compared with the magnitude of the muscles it has to excite into action, it is also one of the largest. Its origin and connexions with other nerves are likewise very remarkable, being derived from the reflected filament of the Vidian branch of the Superior Maxillary portion of the Fifth, and a branch of the Portio Dura of the Seventh pair of Cerebral Nerves, and united with the Gustatory branch of the Inferior Maxillary nerve. It is a difficult matter, however, to determine whether it owes its origin more to the Fifth than to the Seventh pair of nerves, or equally to both; the Aquæductus Fallopii being so small and circuitous, and so encased in the hardest osseous texture in the Body, as to make the investigation almost impracticable. But this is a matter more of curiosity than of importance in our present inquiry: for until we have ascertained the actions, and the effects, of each nervous root and filament, (which belongs to motion, which to volition, and which to perception or sensation,) no benefit, practically or theoretically, can arise from the most accurate information on the subject.

We have alluded to every organ of Sense being provided with a percipient principle, which renders it susceptible to the influence of those properties whose existence it is designed to communicate to the Sensorium. In the Ear, this principle is apparently derived from the Chorda Tympani, which is a compound nerve, and therefore performs a compound action. The muscular textures of the Tympanum are the instruments by which the effects of the Chorda Tympani are exhibited; consequently every effect which the muscles display is passive to the functions of the nerve. Now this percipient principle must be an effect produced by a particular action of life, and have the same analogy to sense which the explosion of the powder of a cannon has to the spark that gave it fire. Every action must be re-

gulated by this vital agent, and every effect which is produced by the sonorous properties in the Membrana Tympani accord with it*. Thus when a weak or a powerful motion is excited in the membrane, by a gentle or violent sonorous impulse, a corresponding effect will immediately follow in the muscular apparatus, and be conveyed, under certain modifications, by the Ossicula Auditus to the Fenestra Ovalis. The one will invariably succeed the other, and be regulated by that agent,—namely, life,—which endows the whole with the principles of motion.

When we take a review of the Cavitas Tympani† in different Crania, we soon discover a considerable variety existing as to its magnitude and figure; but all its parts are so formed as to allow the various structures it contains to perform their functions with the greatest facility. When it is large in all its dimensions, its apparatus is apparently large in proportion, and its muscular structures are more oblique with regard to each other, and consequently contract and dilate to a greater extent, and more forcibly‡: hence, the larger the cavity the more acute is the hearing. This is clearly demonstrated in the Tympanum of many of the inferior animals which are remarkable for being acute in their hearing, such as the Dog, Cat, Hare, &c. But in the Tympanum we observe two kinds of cavities; one for the lodgement of its apparatus, the other

* Some physiologists assign to these muscles powers which they cannot possibly possess. They say that they have the power of excluding excess of sound when it is excessive, and of rendering that which is obscure more distinct. They do not, however, explain how these effects can be accomplished. The muscles have a power of resistance as a matter of course, but they cannot exclude sound unless they can close the Meatus Externus.

† The Cavitas Tympani is deficient in insects, worms, fishes, and many serpents, and in all animals which have no Membrana Tympani. It begins to appear in those reptiles, whether pedated or not, that are furnished with a Membrana Tympani, like animals with warm blood. —*Vide* Scarpa.

‡ This theory is contrary to Sir A. Carlisle's. *Vide* Phil. Trans. part i. 1805.

for a different purpose. The former is perfectly developed at birth, and is commonly known by the name of Cavitas Tympani; the latter is gradually added as we advance in age, and is distinguished by the appellation of Cellulæ Mastoideæ. These cells in Man are generally very extensive; and among those animals which have very acute hearing, they present a greater extent of surface than the proper cavity of the Tympanum. Thus in the Dog, Cat, Hare, &c. they form one large cavity; in the Elephant, and in the Vulture and Owl tribes, they are both large and numerous, occupying a considerable portion of the substance of the Cranium, and giving to its posterior part the appearance of a honeycomb. These circumstances have led physiologists to conclude, that the Mastoid Cells are provided for the purpose of increasing the powers of the organ of hearing; and this idea is strengthened by reflecting, that when the membrane which lines them is inflamed or in any way diseased, a considerable degree of deafness always ensues. But how do these cells increase the powers of hearing? This is a question of some difficulty to solve. We know by experience that the infant at birth has not the power of perceiving sonorous properties, and that even after the Membrana Tympani has become accustomed to their influence, it is liable to be ruptured by the shock from the powerful reports of artillery, &c. We also know, that the effects which these loud reports produce, must be in proportion to the power and the facility which the membrane possesses in responding to them. When the cavity of the Tympanum is large, the strength of the membrane and its susceptibility of motion must be proportionally increased; for it must then have the power of resisting the excessive force of sonorous properties, and also be furnished with a larger space in which to execute its movements; and this the Mastoid Cells, although separated from the Cavitas Tympani by a process of the Membrana Propria Tympani, seem to supply. There are other properties, however, which can with propriety be assigned to these cells; for, since the nerves of the Scalp

are intimately connected with the membrane which lines them, it is probable that these nerves may be concerned in exciting in the Apparatus Tympani, through the instrumentality of the Mastoid Cells, actions in accordance with the sonorous properties which strike against the Scalp.

Connected with the Tympanum is the small trumpet-like tube which extends from its anterior inferior part to the Fauces. This tube, called the Eustachian, exists in every animal which is provided with a Cavitas Tympani, and may therefore be said to be furnished for its use. Constructed as the Cavitas Tympani is, such an outlet appears to be indispensable; for without it the cavity would be impervious, and the motions of its membrane impossible. The Eustachian Tube is therefore provided and formed to permit the motions of the Membrana Tympani to take place, and at the same time to assist in preserving it from being ruptured, by permitting the air to pass and repass out of, and into, the cavity.

The state of the air has evidently a very great effect on the organ of hearing; for when it is cold and dense*, the hearing is very acute; and when it is hot and rare, the reverse invariably happens. This, however, is easily accounted for; for during the continuance of the cold and dense state, all the muscles of the Tympanum must be much contracted and easily acted on by the sonorous properties; and during the existence of the warm and rare condition the reverse must take place. Indeed the properties of the air may be said to affect our hearing in two ways: for they must not only affect the locomotive machinery of the Ear according to the temperature and density, but they must also act on the Acoustic, as on all

* In Captain Parry's Journal of a Voyage of Discovery to the Arctic Regions, he has expressed surprise at the distance he could hear sounds in the open air during the existence of intense cold (4°).—He says: "We have, for instance, often heard people distinctly conversing in a common tone of voice at the distance of a mile; and today I heard a man singing to himself, as he walked along the beach, at even a greater distance than this."

other Nerves, according to the effects which they produce on the surface of the Lungs and on the general habit.

Having now taken a brief view of the functions which the different structures of the Tympanum apparently perform, we shall next proceed to the consideration of the offices of the Fenestræ.

The membrane of the Fenestra Ovalis is perhaps the most important belonging to the organ of hearing. It exists in every class of animals, excepting the Squamose Fishes and the genus Sepia; and only with this difference, —that in insects, cartilaginous fishes, and some aquatic pedated reptiles, as the Salamandra, the Foramen is closed by a membranous or cartilaginous Operculum, whilst in other animals it is stopped by the Ossicle of hearing, which is always intimately connected with the membrane of the Fenestra. This membrane may with some propriety be considered as being to the Labyrinth what the Membrana Tympani is to the Tympanum, or what the Crystalline Lens of the Eye is to the Retina: for from its intimate connexion with the internal extremity of the chain of Ossicula Auditus externally, and the Pia Mater which covers the Acoustic Nerve internally, it must have the power of receiving from the former, and of immediately conveying to the latter, the effects which the actions of the Apparatus Tympani produce when excited by sonorous properties. It concentrates as it were into a focus the whole of these effects, and then transmits them along with its own, through the intervention of the Aqua Labyrinthi, to the Acoustic Nerve, from which the consequent sensation is immediately conveyed to the Sensorium.

Nothing can display the frugality of Nature, or the mystery of her works, to greater perfection than the membrane of the Fenestra Ovalis,—a membrane which, when excited by the Basis of the Stapes, performs more important functions than any other part of similar dimensions in the Body, and when diseased deprives us of a sense the most pleasing as well as the most useful in the animal œconomy. But for the known importance of its function,

this little membrane would probably never have arrested the attention of the anatomist and physiologist for a moment. A very remarkable circumstance is, that the membrane of the Fenestra Ovalis, though performing peculiar functions, should be merely a portion of that one which covers every nerve in the Body. In contemplating the animal machine, no part fills the mind with greater wonder than this membrane,—a structure extremely thin and semitransparent, occupying a small semilunar hole, the diameter of which does not exceed the eighth part of an inch, and yet possessing the power of concentrating all the effects which the innumerable sonorous properties produce in the Apparatus of the Tympanum, and of conveying them to the sensitive theatre of the Ear;—the means are truly insignificant compared with the magnitude of the end. That we should be indebted to so flimsy a texture, moved in various ways and degrees by the base of the Stapes, for all the pleasures arising from eloquence and music, is truly surprising. But the mysteries of Nature surpass all comprehension. The more we dive into her secrets, the more do we become embarrassed and perplexed with the littleness of our understanding.—But to proceed.

If the Eustachian Tube is furnished, for the purposes that we have mentioned, to the Tympanum, the membrane of the Fenestra Rotunda, which we have next to consider, may, for analogous reasons, be said to be provided for the completion of the Cochlea. The Fenestra Rotunda is found wanting in every animal whose organ of hearing has no such cavity; but in all of these* we also find that the organ has no Ossicula Auditus, so that we might as well suppose the membrane in question to be provided as a complement to the bones of hearing as to the Cochlea. To remove this objection, however, a very little reflection only is necessary. We have but to consider what kind of cavity

* The Fenestra Rotunda is deficient in all animals which have no Cochlea or Tympanum,—such as insects, worms, fishes and reptiles. It begins to appear in birds, and is very conspicuous in quadrupeds and in man.—*Vide* Scarpa.

the Labyrinth would be, did not such a membrane as that of the Fenestra Rotunda belong to it, whilst it was at the same time provided with an Ossicle of hearing. It would then be impervious and unyielding; and, its Foramen Ovale being completely shut by the base of the Stapes, its contents would be rendered incapable of motion, and the theatre of no other actions than those of ordinary nutrition. Every motion which the Apparatus Tympani is capable of communicating would then have extended no further than the margin of the Foramen Ovale; and deafness, as a matter of course, would have been the result. To prevent such effects from occurring, Nature has provided this little opening, and furnished it with a membrane which responds to all the actions of the Membrana Fenestræ Ovalis. It is therefore apparently provided to enable these motions, which are necessary to the evolution of the sense of hearing, to take place in the different structures of the Labyrinth, when the Membrana Fenestræ Ovalis is excited into action by the motions of the Apparatus of the Tympanum. It must also serve to prevent the Base of the Stapes from producing any kind of injurious pressure upon the sensitive textures of the Labyrinth*.

When we refer to the writings of others on the Fenestra Rotunda, we find that some very strange notions have been entertained respecting its uses. Scarpa, who has examined the organs of hearing of more animals than perhaps any other anatomist, considers it as a Second Membrana Tympani, and has described it under that name, and as of the utmost importance towards the perfection of hearing. Thus he says, "that as the office of the First Membrane is to transmit the sonorous tremours which it receives from the Auricle to the Labyrinth, partly by the Ossicle, and partly by the air contained in the Cavitas Tympani; so this Second Membrane is designed to

* In the Marmot and Guinea-pig the Stapes has an osseous bolt passing through its centre or body, called the Pessulus, which prevents the bone (the Stapes) from passing through the Fenestra Ovalis into the Vestibulum.—*Vide* Phil. Trans. 1805, part i. page 95.

receive these oscillations of the air in the Cavitas Tympani, to increase them by its own vibrations, and to impart them to the water in the Scala Tympani. Thus the most perfect hearing is effected by two passages of Sounds." Now these ideas appear to me to be altogether hypothetical, and even erroneous; we have no proof of such a kind of motion being produced in the Membrana Tympani; we are certain that no motion can be excited in the Membrana Fenestræ Rotundæ, except through the medium of the Membrana Fenestræ Ovalis communicating its motions to the Aqua Labyrinthi, and through this to the membrane in question. But this Physiologist has gone great lengths with his ideas; for when he alludes to the Cavitas Tympani being in the Fœtus always filled with a fluid, he says:—"Non ego dicam in emoriente homine unam, eamdemque esse peculiarem humorum condensationem, ex qua fortasse mucus enascitur, quæ tum auditum hebetat, cum visum obtenebrat, sed illud vel maxime advertam, statim auditus hebetudinem, jacturamque consequi, si quando non dicam mucus, sed humiditas nimia tympanum infarciat. *Hinc ejus cavitas in fœtibus humoris copia provide redundat, ne scilicet sonori radii vim suam contra proximum organum auditus affectionibus illis adhuc inassuetum valide exerceant.*"—Scarpa *De Struct. Fenest. Rotund.* cap. iii. § ix.*

* In the Phil. Trans. vol. xxvi. p. 485, we find a case, related by the Rev. William Derham, of a Fœtus crying occasionally every day *in utero* during the last five weeks of gestation, which the *learned* divine firmly believed to be true, (although he had no opportunity of hearing it himself,) because it was so stated to him by the mother, the midwife, and the whole neighbourhood. This absurd story was very justly ridiculed by all the learned of the day, and in particular by Etmuller and Diemerbroeck, who considered it to be merely a croaking of the intestines, or the effects of feminine imagination. The Reverend author, however, in spite of the conclusive arguments which his antagonists brought against him, endeavoured to defend his credulity, first, by stating the words of the mother, "that the noise the child made was as if a born infant had cried eagerly shut up in a tub;" and next, by referring to the writings of others, where similar cases are related, and particularly to those of Verzascha of Basle, who in his *Observ. Medic.* relates the cases of Ant. Deusingius in his *Dissert. de Generat. Fœtus;*

The Labyrinth.

If, in the course of our investigations, we have found the functions of the different textures of the Tympanum beset with difficulties, those of the Labyrinth may be justly said to be insurmountable; for the whole of its apparatus is not only so placed as to be beyond the reach of observations and experiments, but is also so curiously constructed as to bear no analogy to any other part of the Body. Neither do the organs of hearing of the Inferior Animals which have been explored, furnish us with any accurate ideas on the subject. They may be said to demonstrate the frugality of Nature in her contrivances, but nothing else. In proof of this we have only to adduce the following examples. In the Genera Cancer and Sepia, we find the Labyrinth to consist of a single cavity, called the Vestibulum. In the Spinous and Cartilaginous Fishes, we observe it composed of a Vestibulum and Semicircular Canals: and in Birds, in addition to these parts, we notice a deep conical cavity, called the Cochlea. In Birds, we find that the Semicircular Canals are, in general, large in comparison of the magnitude of the animal;—thus, in the Goldfinch they are nearly half as large as they are in the Otter or Cat, and in the Eagle they are larger than in the Horse or in Man. The position of the Semicircular Canals in Birds relatively to each other is also different from what it is in Man and Quadrupeds; for one of the Canals intersects another near its middle at almost a right angle; and the terminations of all are so placed as to permit a hog's

Dr. Needham's case of an English lady of quality in his *De Formato Fœtu*, and that of Christian II. King of Denmark, who was heard to cry *in utero* by almost the whole Court. Etmuller appears to have at first partly believed the Rev. Divine's story of a Vagitus Uterinus, from the circumstance of chickens chirping in the egg for several days before they are hatched:—but the absurd explanation of the cause of the Fœtus crying, viz. that of a bone irritating it, is, I think, of itself sufficient to make the most credulous discredit the whole affair; and I cannot for a moment suppose that Scarpa drew the above conclusion from such data.

bristle to pass from one into another with facility. Among the different Quadrupeds we notice the Labyrinth consisting of the same number of cavities, each of which partakes of the same figure it possesses in Man. Indeed the only difference observable is, that some have the Cochlea large in proportion to the Semicircular Canals, and others the reverse. These differences can only prove that every species of animal is provided with its own kind of Labyrinth, furnished with powers or properties adequate for the evolution of those actions which are necessary to its œconomy. Such varieties of structure do not elucidate the use of any particular cavity, or even give us occasion to deduce any plausible conclusions on the subject. It has nevertheless been stated by a late writer*, "that the ultimate cause" of Man's being provided with such a complex structure, "is the greater power with which he is endowed of receiving through the Ear various impressions of simple sounds;—language, music, and various modifications, of the sense of which the lower animals are probably incapable." But this mode of reasoning is at variance with the phænomenon of sound and also inconclusive; for it merely tells us in general terms, that of all animals Man is the superior, and that, from the extent of his capacities, he requires an organ adapted to perform the various functions which pertain to him in his position as chief of created beings.

Foiled in our attempts to obtain from comparative or human anatomy any information on this subject, we are naturally led,—from observing that the organization is universally in relation to the œconomy of animal life,—to investigate the functions of the Labyrinth by comparing its structures with the peculiar propensities exhibited by different animals. By means of the relationship which always exists between structure and function, we trust that we shall be able to throw some light on the subject of our inquiry. Yet, even in entering on this path of in-

* Sir C. Bell, in J. and C. Bell's Anatomy.

vestigation we are met by great difficulties; for in no two kinds of animals do we find exactly the same propensities combined with the greatest possible similarity in the form or structure of their Labyrinths respectively. For example, we find that the Pike is attracted by music, whilst the Shark is not*; that the Lark and Goldfinch sing, whilst the Eagle and Vulture do not; that the Dog is fond of tumultuous sounds, and has an aversion to music†, whilst the Cat seems to have no relish for either; whereas the Hare is pleased with both; for that timid animal will often choose its quarters in the neighbourhood of a dog-kennel, and will be brought close under the windows of a house by the sound of the piano-forte‡. But the most obvious, as well as the most remarkable distinction, is in the Horse and the Ass; in the former there exists at first a considerable degree of timidity on hearing either musical or discordant tones; but after a little training, the inclination of the Horse becomes completely changed, for he then evinces a strong liking both for music and noise. Indeed, I have seen a horse lick a drum with his tongue whilst the roll-call was sounded on the instrument; and another advance at a rapid pace to a battery of artillery when the guns were firing. The Ass, on the other hand, never exhibits either great liking or aversion to any kind of sound. And yet among all the animals which we have now con-

* Boyle says, that the tinkling of a bell will bring fishes to be fed; and Ælian tells us, that the crab (Cancer Pagurus,) is caught by music; but Minasius, who is more worthy of credit, denies this.

† See a curious account related in Dr. Mead's Works, 4to, p. 76, of a Dog dying from the effects of music; and also, p. 68, of the bite of the Tarantula being cured by music only. See also the Gentleman's Magazine, vol. xxiii. for an account of the tune which is said to possess such alexiteric virtues.

‡ The powers of music are very remarkable over a variety of animals. Only witness how fond the lizard is on hearing a lively air,—how he erects his head with one side generally higher than the other, and opens his mouth; for he hears best with his mouth open, and remains apparently motionless. But the charms of music are said "to cure fevers:" *Vide* Gentleman's Magazine, vol. xxiv. p. 69, 1754.—Query, of what kind?

trasted, the difference of structure that exists in their respective Labyrinths, is so little as to be barely discernible.

With respect to those phænomena called dispositions, likings, and propensities, which we have been induced to notice, we may observe, that they clearly prove, what I believe is now very generally admitted, namely, the dependence of these mental attributes not upon the structures and form of the organs of sense, but upon some particular cause existing in the Sensorium; in other words, that the Brain is, when excited by a particular principle of life, the active, and the organs of sense the passive, agents in their manifestation. We can neither see, hear, taste, smell, nor feel, until the Brain becomes the theatre of actions coinciding with those of the organs of sense; which actions, in their turn, can only be produced by the living and sentient principle.

The Count de Buffon*, who has investigated the phænomena of sensation with great ability, has endeavoured to modify the idea of the passiveness of the organ of hearing. Thus we find he says, "L'ouie est bien plus necessaire à l'homme qu'aux animaux; ce sens n'est dans ceux-ci qu'une propriété passive, capable seulement de leur transmettre les impressions etrangères. Dans l'homme c'est non seulement une propriété passive, mais une faculté qui devient active par l'organe de la parole; c'est en effet par ce sens que nous vivons en société, que nous recevons la pensée des autres, et que nous pouvons leur communiquer la notre, les organes de la voix seroient des instrumens inutiles s'ils n'etoient mis en mouvement par ce sens; un sourd de naissance est necessairement muet, il ne doit avoir aucune connaissance de choses abstraites et générales." There can be little or no doubt entertained as to speech being of a secondary or passive nature, and subservient to some particular action excited in the Brain by the action of the Acoustic Nerve; for children who are born deaf are also dumb, and remain so until the action

* *Vide* Buffon, tom. iii. p. 347.

in question is excited by the sonorous properties transmitted through the Auditory Nerve :—but we cannot, with propriety, consider this percipient function of the Ear as an active quality ; it can only be regarded, like every similar action in any other organ, as the relative antecedent ; for the sight or smell of grateful food will, whilst it excites the eye or the nose, also arouse appetite, and call into action the functions of the stomach*. But we need not refer to the functions of other organs, either to prove the inconsistency of Buffon's conclusions, or to elucidate the true nature of the phænomena at issue ; for we have only to trace the Acoustic Nerve to its origin, and the intimate connexion which exists between the Ear and the Larynx is immediately explained. In the Brain we find the Fifth and Eighth pairs of nerves as closely connected with the Seventh, as the links of a chain are with each other. In some animals this union is still more intimate than in Man ; as for example, in the Cat, in which there exists a direct communication between the Fifth and Seventh pairs of nerves. Moreover, in Insects, Worms, and Fishes†, the Nerve of hearing is a branch of the Fifth, or, at least, of that nerve which resembles, or seems to correspond to the Trigeminal. From this intimate connexion, and from the general law of a person born deaf being also dumb, we must infer that the functions of the Acoustic Nerve harmonize with those of the Vocal, and that the Brain, when excited by the actions of the Ear, must possess the power of directing those of the Larynx, and consequently of enabling its nerves to bring into play the structures of the Organ of speech. This particular function of the Brain has long been known, and expressed by the term Sympathy‡ ; but sympathy, in whatever way it may be under-

* For an illustration of this see Whytt on Nervous Disorders.

† *Vide* Scarpa.

‡ "In the animal body there are actions which proceed from certain fixed principles in the animal œconomy, and are regulated by certain fixed laws. Those actions which arise from other actions, are called Sympathetic, and those which arise from force or violence, done to the first principle, are called Habitual."—J. Hunter.

stood, is a very obscure term ; for it does not explain the nature or the principle of any action, general or particular ; and in the sense in which it is generally taken, the word is altogether inapplicable here : for every action in the Body is mutual ; no one can exist of itself ; all are, like the materials by which they are evolved, of a compound and relative nature ; "they all concur, (as Baron Cuvier has forcibly expressed it,) by the means of reciprocal influences, in the production of a common end, and thus form together a whole, a perfect system."

As to Buffon's assertion of a person born deaf and dumb having no idea of abstract or general knowledge, we may only observe, that although the inference coincides with the case recorded in the Memoirs of the Academy of Sciences, for 1703, page 18, it is at variance with every case recorded since that period*.

But, to return from this digression into which we have been insensibly led, we proceed to state, that however vague our knowledge of the functions of the different cavities of the Labyrinth may be, it is obvious, from Nature being so frugal in all her means, never making anything superfluous, that the Sense of Sound must owe its perfection, not to the office of any particular cavity, but to the united co-operation of the whole. Thus, when the Membrana Fenestræ Ovalis has performed its functions, the actions which instantly follow must be conveyed to the whole surface of the Pia Mater, which covers the pulpy expansion of the Acoustic Nerve, by the motions of the Aqua Labyrinthi (where probably one kind of action is excited in one cavity, a different one in another). And

* For an illustration of this, see the case of J. Mitchell, recorded in the Edinburgh Medical Journal, vol. ix. p. 473 ; also that recorded in Tilloch's Phil. Mag. vol. li. p. 129 ; also that of S. Fulford, (in this treatise,) who exhibited no deficiency of intelligence on being restored to her hearing and speech. From my own experience, I am inclined to think, that when a deficiency of intelligence is apparent in the deaf and dumb, it is much oftener presumed than real, and arises from a want of language to express rather than from any lack of ideas.

it is by the united co-operation of all the parts that the actions necessary for the evolution of the Sense are, we may presume, completed, and immediately afterwards transmitted through the Nerve to the Brain.

The Aqua Labyrinthi, which appears to be the medium by which the functions of the Membrana Fenestræ Ovalis are conveyed to the Acoustic Nerve, produces no sensible effect in the latter, except when it is excited by the actions of the former. For, although it must be kept in constant motion by the functions of its secreting vessels and absorbents, it is only by the motion it receives from the Membrana Fenestræ Ovalis, that it performs the ultimate intentions of Nature. From the Abbé Nollet's experiments, some physiologists have inferred that the Aqua Labyrinthi is secreted, and placed where we find it, because water transmits more strongly the vibrations of sound than air; but this conclusion is at variance with another experiment of the same philosopher, where he ascertained that in water the more sonorous the bodies struck were, the less vivid was the impression. These experiments merely prove that water is a better and more expeditious conductor of sonorous properties than air, and that water destroys the resonance or peculiar characters of these properties; but neither of these phænomena gives us the least idea of the question at issue. They only prove that the functions of the Aqua Labyrinthi are totally different from any other fluid in or out of the Body, and that to acquire a knowledge of its mode of action, we must direct our attention in a different channel.

In considering this subject under another point of view, I beg leave to remind my reader that the first effect of motion must be to occasion pressure, and that no sensation can be developed without this concomitant. This is an axiom that coincides with experience*; for we know

* It is unnecessary to notice the laws of pressure, or the nature of the moving powers in a work of this kind; but those who are anxious to acquire a knowledge of the subject can easily obtain it in any work upon Natural Philosophy, under the head of Mechanics.

of no sensation that can be produced without pressure. Of the five senses, those of Touch, Taste, and Smell, are the most obviously dependent on this cause for their development: but the remaining two, Sight and Hearing, are soon discovered to be equally so; for rays of light, when collected into a focus*, can drive before them flimsy substances, and sonorous pulses cause vibrations in the chords of a musical instrument, that are in harmonic proportions with them. But this effect, which the sonorous properties produce, will, perhaps, be considered as inapplicable to the Aqua Labyrinthi, on account of its situation; for whatever pressure the wave of sound may have the power of making, must be made first on the surface of the Membrana Tympani, and only through this and the Apparatus of the Tympanum be transmitted to the Labyrinth. To remove this objection, however, we have only to compare the Base of the Stapes with the magnitude of the Foramen Ovale. When the bone is placed *in situ*, we find that it can pass into the Vestibulum with the greatest facility. Its muscles also, on examination, are found to have the power of drawing it inwards, and consequently of producing a pressure on the fluid contained in the Labyrinth. And, besides, when we refer to Comparative Anatomy, we find that the tribe of Birds have only one Ossicle of hearing, which extends from the Membrana Tympani, in a direct line to the Membrana Fenestræ Ovalis,—that the Membrana Tympani is convex externally, and that no motion can consequently take place in it without producing a pressure upon the Membrana Ovalis, and through the medium of the latter upon the Aqua Labyrinthi. Should further information be considered necessary, pa-

* Perhaps some will doubt the truth of this, because, when we collect the rays of light into a focus, we also collect their accompanying degrees of heat: but if light be, as it has been ascertained, composed of minute particles of matter, these particles must have the power, when concentrated, of moving a body as well as heat, although, perhaps, not so forcibly. For further particulars, *vide* Monro's Anatomy, by Rotheram, vol. iii. p. 273.

thological Anatomy furnishes us with it; for we find, whenever the fluid of the Labyrinth is absent or changed in its nature*, or when the Base of the Stapes is anchylosed, that the patient is rendered totally deaf. The first influence, then, to which the Aqua Labyrinthi is susceptible, is *pressure*, and the next is motion of a particular kind, accompanied by a slight alteration in figure. The moment the Stapes is moved inwards, a corresponding degree of pressure and motion must immediately be produced in this fluid, and the motion will necessarily force the Membrana Fenestræ Rotundæ outwards, and cause the change of figure just alluded to. But this pressure and its concomitants do not always depend upon the Stapes being moved inwards; for in whatever way that Bone is moved by its muscles, still the Membrana Fenestræ Ovalis will invariably follow, and of course carry the fluid along with it, producing those changes which, we may presume, are essential to the evolution of the functions in which it is concerned. What these particular functions of every texture and fluid within the Labyrinth of the Ear are, will, I fear, for ever remain among the arcana of Nature; but that all are essential to the cognizance of sounds of different kinds, cannot, I think, be doubted.

* See a brief account of some of M. Pinel's dissections of the Ears of old people, in the Medico-Chir. Rev. vol. vii. p. 299. See also Mem. Medical Society Lond. vol. iii. p. 1; and Phil. Trans. vol. xci. p. 435.

CHAPTER III.

CONGENITAL DEAFNESS.

When the generating or reproductive properties of the animal œconomy are investigated, they are commonly viewed as being endowed with the power of producing, in accordance with their nature, an animal perfect in all its organs and systems. The reproductive properties are seldom thought of as being exposed to a variety of deranging or interrupting causes. To show the fallacy of this view, we have only to advert to the evident changes to which every existence in nature is subject. Like everything else, the reproductive properties of life are exposed to the influence of various local or accidental circumstances. The phænomena of hereditary diseases proclaim also the possibility of these properties being faulty in themselves. From the regular transmission of life from parent to offspring, it would appear, however, that local causes, or even hereditary diseases, must only modify certain portions of these generating properties, so as to prevent them from causing the perfect development of the new Being. Hence, when a new-born animal exhibits defects in any of its organs, these are invariably of a local nature; and the functions for which the defective organs were intended, are either totally absent, or so limited as to be unable adequately to answer the intentions of nature. Thus, for example, when any imperfection exists in the eyes, or the ears, it always produces congenital blindness in the former, and deafness in the latter; and when in the legs or feet, congenital lameness. Now in order to have a correct idea of the causes of these imperfections, we have only to recollect that every atom of the Primordium of the Male, and of the Ovum of

the Female, has properties, and is continually in action; and that when the two are placed in apposition in the Uterus, the actions of the Semen Masculinum are sustained by those of the Ovum, until they arrive at that period when they require the presence of other matter for their growth and continuance. This other matter is furnished from the blood of the Female, and transmitted through the medium of the vessels which connect the Germ to the surface of the uterine cavity; and of course is subject to the influence of all the actions to which the mother is exposed: for whatever affects the functions of the heart or brain, affects in like manner the properties of the blood, and produces effects coinciding with them. Those which take place in the substance of the uterus must necessarily interfere with the uniformity of its actions, and consequently with the harmony which exists between that viscus and the primordium; and the result must be the production of organs in the Embryo or Fœtus, partaking of this discrepancy. When, for example, the actions which are necessary to the formation of the Embryo or Fœtus, having arrived at the stage of generating the brain, or the eyes, or the ears, or any other part, become preternaturally excited by any irregularity in the functions of the uterus, the different textures of the part in the act of being developed will correspond with the faulty nature of that excitement. They will be defective either in substance, or in form, or in both; and the imperfection, in whatever organ or texture it may be, will be productive of corresponding effects. The beautiful symmetry of the body will be destroyed, and its powers as an organic machine so implicated, as to render it incapable of performing all the actions necessary to its œconomy.

When we reflect for a moment on the entity of life, on the various actions to which it is exposed, the facility which nature possesses in accommodating the means to the ends, and the innumerable accidental or local circumstances which accompany its various evolutions, we can easily conceive, when its actions are at any time inter-

fered with, that they will immediately display irregular effects, and consequently produce organs of an imperfect nature. When these organs happen to be the eye or the ear, the foundations of congenital imperfections, of a nature the most distressing with which the animal œconomy can be visited, will invariably be laid: for the blindness and the deafness to which they give rise, will generally exist during the whole period of the individual's life. We say generally, because we know by experience that life becomes sometimes endowed with the power of removing them, by the evolution of actions without any apparent cause. But there are different degrees or species of congenital blindness and deafness; for we sometimes find individuals totally blind or deaf, and others only partially so. This variety evidently arises from the magnitude of the malformation and the importance of the structure in which it is seated. It is to the investigation of the phænomena of defective formation, as they implicate the organ of hearing, that our attention is now to be directed, with a view to their alleviation or removal.

Every one who has attentively examined the development of the organ of hearing must be sensible, from the complexity and delicacy of its apparatus, that its vessels, when excited by any local or accidental cause, are very liable to take on irregular or faulty actions, and consequently to lay the foundation of congenital deafness. It is, however, a fortunate circumstance that local or accidental causes, unless of a very powerful nature, seem to have very little effect on primary or general principles; and that those of the Primordium are of this kind: for the Germ, when lodged in the cavity of the uterus, can only be viewed in the same relationship as a barleycorn, when placed, during the spring, in contact with its maternal elements. It must possess in itself the power of commencing certain actions, and of producing certain effects, each of which can, as already stated, at most be only modified by the properties of the matter furnished for its support, unless it be itself in a faulty or diseased state.

The distressing phænomenon of congenital deafness, from faulty organization, may owe its origin to a variety of causes, some of which may have their seat in one, or all of the structures of the Labyrinth, and others in those of the Tympanum. In the Labyrinth we find, as already demonstrated, a process of the Dura Mater lining the different cavities, and no doubt performing the same functions which it does in the cavity of the Cranium; for its external surface composes the Periosteum of these cavities, whilst its internal, in all probability, gives off a fluid to lubricate and preserve the delicacy and motions of the adjacent process of the Pia Mater. We also find this latter membrane in like manner expanded, with the Acoustic Nerve spread out between a duplicature, or two of its laminæ, the inner surface of which, from forming a kind of bag and secreting a fluid, is termed Saccus Vestibuli. These three structures, arranged in different layers, are again interwoven with several others,—such as arteries, veins, absorbents, and nerves; and though it is upon the united co-operation of all of them that the functions of the Labyrinth necessarily depend, yet each is liable to its own mode of derangement, and may therefore have a special as well as a general influence in producing congenital deafness.—The same remarks are applicable to the different structures of the Tympanum.

When we reflect on these circumstances, and on the relative importance of the functions performed by each of the structures of the Ear, we may easily conceive, when congenital deficiency of hearing arises from derangement or imperfection in all, or any of the structures of the Labyrinth, that it will be apt to exist in a greater degree, and to be of a more irremediable nature, than when it is owing to malformation, or disturbance of all, or any of the textures of the Tympanum. The deafness in either case must accord in extent with the magnitude of the cause. When, for example, the deafness arises from a disorganization in the textures of the Labyrinth, the sense of hearing will be in general completely destroyed; and when it arises

from a derangement in the textures of the Tympanum, the sonorous pulses which proceed from powerful causes,—as the firing of cannon, the ringing of church bells, &c.,—will be able to excite an action in some part of that cavity or of its structures; and this action will, on being transmitted to the Labyrinth, produce an effect coinciding with it, so that the sense will not be quite lost. But when the cause of the deafness is seated in one texture only in either of the great Auditory Cavities,—such as in a portion of the Dura Mater or Membrana Tympani,—the severity of the deafness will not correspond with the apparent magnitude of the cause alone, but also with the importance of the function which the part disordered performs. These conclusions are so obvious, that further remarks will, perhaps, be considered by many as superfluous; but as the prognosis in every case must necessarily depend on an accurate knowledge of the derangements, or imperfections to which the different textures are liable, it appears to me necessary, from our ignorance of the diagnostic symptoms which attend the deafness arising from each of these imperfections in particular, to venture a few observations on the subject here. I do not, however, pretend to enter into the consideration of this part of my inquiry so fully as I could wish; for I confess, I am not only entirely ignorant of the laws which govern the fœtal œconomy, but my opportunities of investigating the causes of congenital deafness, in all its bearings, have hitherto been but limited. I must therefore content myself, for the present, with taking a cursory view of some of the more obvious morbid and preternatural phænomena to which the textures of the Ear are liable.

We have already alluded (page 34) to the changes which the Petrous Portion of the Temporal Bone undergoes at different periods of life: from being among the softest and most vascular osseous textures in the body, it gradually becomes the hardest and the least vascular. This change necessarily renders it liable to be the seat of various morbific and morbid phænomena. In scrofulous constitutions

we know by experience that the whole of the osseous textures in the body are often in a diseased state; that their vessels in general perform morbid actions, by secreting fluids which are frequently deficient in a due proportion of phosphate of lime; and consequently, that these organs, which in the healthy subject are of considerable strength and density, are in the scrofulous generally soft and spongy, or, in other words, morbidly vascular. We also know, that in infancy all the textures of the body are highly vascular; and it is probably from this circumstance that scrofula appears in a more active form during the earlier than the later stages of life. Now when we reflect on these peculiarities, we must necessarily conclude, when congenital deafness exists in a scrofulous constitution, that it may, in many instances, arise from a morbid softness in some part of the osseous textures of the Ear. Indeed we are told* that when scrofula attacks the organ of hearing in an active form, it sometimes not only destroys the whole of its textures, but also extends to the cavity of the Cranium, and proves fatal to life.

In scrofulous constitutions the actions of the heart and arteries are generally above the healthy standard, the breath and perspirable matter possess a peculiar fœtor, and the renal discharges are frequently of a porter-colour, and deposit a sediment having very much the appearance of brick-dust; and yet, notwithstanding the existence of all these phænomena, little or no constitutional disturbance will apparently exist. A very remarkable circumstance attending the existence of a scrofulous diathesis, consists in its active symptoms occasionally passing over one generation and appearing again in the next; so that the grandfather and grandson shall be both affected with scrofula, while the link which connects the two together shall be exempt from any appearance of the disease. Now, since no action can exist without a cause, we must necessarily infer, from the existence of such effects, that in the blood

* *Vide* Hamilton on Scrofulous Diseases.

reside their relative causes,—consequently that this fluid, in scrofulous constitutions, must have properties inimical to those actions which are requisite to the formation of a perfect organic machine. What the nature of these properties may be, is a very difficult question to answer,—whether it is in an alkaline, acid, or earthy principle that it consists, or whether it is merely vital—has never been satisfactorily ascertained, although, from the frequent occurrence of the scrofulous diathesis, accurate information on this subject would be of the first importance in the practice of surgery and medicine. From the frequency of the action of the heart, together with the other phænomena which we have mentioned, it appears, however, that the causes of scrofula, as they exist in the blood, must partake more of an irritating than of a soothing nature. In the development of the Embryo and Fœtus, these irritating properties must necessarily produce a considerable waste or transmutation of substance, and consequently cause a privation of healthy matter for the support of its different actions. Its osseous textures, and in particular those which envelope the organs of hearing, must therefore, from the lateness of their completion, and from the nature of the excrementitious secretions, be very much exposed to the effects of that privation, and thus lay the foundation of congenital deafness.

There is another disease which is somewhat analogous to scrofula, inasmuch as its actions are inimical to the healthy principles of life, namely, siphilis*. Children who are the issue of siphilitic parents, are frequently of weak, lax constitutions, and very much out of health. This, *à priori*, is what we should, in the absence of experience, have been led to expect; for in these cases, the Primordium must, as in scrofula, contain the rudiments of those actions which are both peculiar to the self-preserving principles of the animal œconomy, and also opposed to them: for in every disease there must exist a something

* *Vide* Bell on the Lues Venerea.

in the form of matter to cause a perversion of the healthy functions of life; and that something must, from the nature of the phænomenon we are now considering, and the source from which the Germ or Entity is taken, be productive of effects of a very distressing kind. Hence we find in congenital siphilitic Infants, that a fœtid discharge of irritating purulent matter frequently issues, sometimes from the eyes, sometimes from the ears, and sometimes from both; and that these organs are, at birth, occasionally in such a disorganized state as to be apparently incapable of performing their functions. When the organs of hearing are the seat of siphilis, the discharge is generally found to proceed from a diseased action existing in their osseous textures, and to continue until the whole of the Tympanum, and sometimes the Labyrinth, are destroyed, the consequence of which is permanent and irremediable deafness.

The osseous textures of the Ear are, however, liable to a number of other diseases besides those just noticed, and likewise to a variety of malformations. The latter are frequently the cause of congenital deafness*: for in the structure of the various cavities of the Labyrinth, we notice both a peculiar figure and a particular delicacy in the fibres of the osseous laminæ, which do not appear in any other bony structure of the Body. This departure of nature from her usual mode of forming the osseous textures, shows that the actions of the secreting vessels in the bony parts of the Ear differ from those that obtain in every other bone; that they are governed by laws peculiar to them-

* Cotunnius dissected an Ear, the Foramen Rotundum of which was entirely obliterated, and the Ossicula Auditus, and especially the Stapes, twice the usual size; as if Nature indicated (says he,) "ampliori stapedis pressione majorem se motum, vestibuli humori cochleam petituro procurasse, ut qui antea scalæ tympani humor a tremore membranæ fenestræ rotundæ, et a vestibuli humore in suum erat aquæductum impellendus, deficiente membrana, solo humoris vestibuli motu impelleretur." But he gives no account of the hearing of this man. —*Vide* Cotunnius *de Aquæductibus Auris Humanæ internæ*, § lxxii.

Mendinus found the Cochlea composed of only one turn and a half. —*Vide* Medical and Physical Journal, vol. xliii. p. 519.

selves; and are consequently subject to their own modes of derangement, besides such as arise or continue to exist from general or constitutional causes. For when we consider the mutual dependence which all the actions of a living being have upon one another, how much those which evolve the Embryo and Fœtus are exposed, from their connexion with the uterine functions, to the influence of accidental causes, and how one faulty action may produce many; we can easily conceive how liable these formative actions must be, to be turned aside from their regular course; and from the intricate mechanism of the Ear, and the peculiar actions of its secreting vessels, how exposed it must be in particular, when being formed, to the influence of such causes of derangement*. When the actions that preside over the development of the osseous structures of the Ear are defective, these structures are necessarily defective also. When the defect is in the entire shell of the Labyrinth, or in only that portion which belongs to the Cochlea, or Semicircular canals, or Vestibulum, or Fenestræ, the sense of hearing will, for the reasons assigned page 68, be entirely destroyed, and relief altogether beyond the power of man; but when the mischief has its seat in the Shell of the Tympanum, or in the Ossicula Auditus, the extent to which the sense of hearing is impaired will correspond with the amount and nature of the disease or malconformation, and the importance of the part or parts implicated. It will also frequently admit of being remedied to a considerable degree.

But the osseous are not the only structures of the organ of hearing which are liable to become the theatre of morbid or preternatural actions; for the processes of the Dura Mater which enter into the composition of the Laby-

* Various attempts have been made by Physiologists to account for congenital deformities. Some have considered them as the effects of the imagination, some of disease, and some of accidental adhesions to the Placenta; but Mr. Lawrence's paper on this subject in the Medico-Chir. Trans. vol. v. p. 167, contains a complete refutation of all these vague and absurd ideas.

rinth, are as much exposed to become the seat of such effects as the bony case that contains them. Indeed, we are inclined to think, as the Serous Membranes of the body seem generally to be more predisposed to disease than the bones, that these processes must be more frequently affected than the osseous textures; and this opinion is strengthened when we reflect that it is from the vessels of the Dura Mater that the Petrous Portion derives its chief support, and that this part is, in the earlier periods of life, one of the most vascular bony textures in the body. Now we know by experience, that the Dura Mater is very liable to become the seat of inflammation, ossification, and a variety of morbid growths; and that when the part which covers the Petrous Portion of the Temporal Bone is affected with inflammation, the disease may terminate in suppuration, caries, or induration. When ossification is far advanced, it may even cause necrosis of the entire portion, (*vide* Case); and when it is the seat of tumours, these may produce absorption of some of the parts which are essential to the perception of sound. The processes of the Dura Mater which line the cavities of the Labyrinth are subject to the same morbid actions, which in these, will, of course, produce effects of a similar nature: for if our physiological ideas of these textures be correct, it is obvious, that when the whole, or merely that portion of the membrane which covers the Fenestra Ovalis, becomes indurated or thickened by inflammation, or ossified* by a diseased action of its vessels, the sense of Hearing will, in all probability, be entirely destroyed, and beyond the power of art in any way to relieve it. Various modifications of such a distressing issue will, however, occasionally take place; for although the processes of the membrane in question are evidently of the greatest importance to the perception of sound, it appears that some parts perform more important functions than others, and that

* Valsalva relates a case where the Membrana Fenestræ Ovalis was ossified, and the Stapes anchylosed to it, in which total deafness was the consequence.—*Vide* Valsalva *de Aure Humana.*

when the more important parts are free from disease or malformation, or are only partially affected, that the sense of Hearing will not be completely destroyed, but only rendered excessively dull; and perhaps accompanied with various morbid sensations, owing to irritation in the neighbouring tissues.

With regard to the fluid which the inner surface of the membrane secretes, to lubricate, and preserve the delicacy, and permit the motions of the adjacent Pia Mater to have place; we may observe, that it is, like every other secretion, much affected in the different states of health and disease. The secretion may be either totally destroyed, or so changed in its properties, as to prove the source of very distressing symptoms. Indeed, from what I have seen in the dissection of cases of fatal concussion of the brain, I am inclined to think, when the Ear becomes the seat of such acute pain as to excite delirium, that the symptom may be frequently owing to this cause; for in the cases alluded to, I have noticed, when matter was found between the Bone and Dura Mater, that symptoms of compression only had been present during life, but when the matter was poured out between the Dura and Pia Mater, symptoms of delirium had been very seldom absent*. It is, however, a fortunate circumstance that the child before birth has its percipient powers so imperfectly developed, or generated, as to be incapable of sensation; and when any of its textures are disordered or diseased, that no constitutional irritation or disturbance can therefore be produced. Were it not for this provision of nature, it is probable, when any organ of the Embryo or Fœtus became the seat of disorder or disease, that the irritation which the nervous system would produce, might not only destroy its principles of life, but also be the means of causing so many alarming and distressing symptoms to the mother, as to deprive her of the power of preserving

* My attention was first directed to this peculiarity by Mr. Brodie, to whom I am greatly indebted for the valuable information I acquired when attending his lectures and Hospital practice.

the Species. Be this as it may, however, it appears evident from what we have ventured to state, that when the serous vessels of that portion of the Dura Mater which lines the Labyrinth, perform morbific or morbid functions, the irritation produced will probably extend to the adjacent process of Pia Mater, and prove destructive to the sense of Hearing.

The Pia Mater, which forms a part of the textures of the Labyrinth, and is in contact with the expansion of the Acoustic Nerve, is the most vascular, and therefore the most important texture, in a physio-pathological point of view, belonging to the Labyrinth; for it not only protects the tender medullary substance which it envelopes, but its vessels secrete, and of course nourish and vivify that material as well as supply the fluid which floats in its sac. This variety of function must necessarily render it very liable to disorder and disease; for the more complicated anything is, the more susceptible is it of derangement. We have only to reflect, that during life, every vessel is continually in a state of action, which is influenced by, and indeed owes its existence to other actions of a more general nature, to feel the truth of this remark. Among the different structures which enter into the formation of the Ear, none are, I am inclined to think, more exposed to the influence of those general actions which are necessary to the conservation of life, than the Pia Mater—the membrane we are now considering. Let us only reflect for a moment on the numerous changes which are experienced in the sense of Hearing in the various stages of human life; how liable we are to become very deaf, and sometimes to be troubled with disagreeable noises, when advanced in years; how disposed the vascular system is to become the theatre of ossification, and how every internal function is influenced by external agents; and we shall not be surprised that so delicate a structure as the Pia Mater lining the Labyrinth of the Ear, should be liable to derangements. I am not aware of the vascular system of the Embryo, or Fœtus, having ever been discovered in a state of general or local disease, except in scrofulous or

other hereditary morbific constitutions; but attentive observation informs us, that in every moment of life, from the formation of the Germ to the termination of its career, it is capable of exhibiting morbid phænomena, and that too without our being able to discover, or even assign any apparent cause for their occurrence: for in both Fœtus and Child the principles of life are the same; they are all sustained by the association of the same kind of agents; are exposed to the same kind of actions, and subject to the same kind of effects. Now, what effect is more common in life than fever? And is not that phænomenon produced from a perversion of all the healthy* functions of the animal machine? In fever, every organ, texture and system, is performing morbific actions, and, of course, producing corresponding effects. Thus the heart and arteries are increased in their actions above the standard of health, and are therefore productive of effects inimical to the existence of that condition: the brain and nerves are, in like manner, in a state either of increased excitement or of torpidity, and in both cases are unable to produce, in the different organs of the body, those actions which are requisite to the existence of their healthy functions, &c. In fact, the beautiful harmony which, in health, pervades all the operations of the machine,—the influence by which its different organs are directed to the due performance of their functions, and enabled to co-operate with each other,—is so much disturbed, that every part of the machinery tends, as it were, to derangement;—a condition that sometimes, nay, frequently, continues until the different systems are so much altered as to be incapable longer of continuing their functions.

It is unnecessary to discuss the general morbid effects which fever is capable of producing in the different textures of the Ear. Neither shall I dwell on the various

* Some Pathologists call it a perversion of the *natural* functions; but every change which the body is susceptible of is natural. They all proceed from causes purely natural; and even art itself is nothing else but the application of active principles to passive ones.

appearances which the expansion of the Acoustic Nerve has been discovered to exhibit; for I am inclined to think, from the few cases of congenital deafness which I have had an opportunity of investigating, that the cause of that distressing imperfection is seldom or never seated in the medullary expansion of the nerve. In every case which has come under my notice, I have invariably found that the vibrations of a tuning-key could be conveyed to the Brain, when that instrument was applied to the surface of the Head,—an effect which clearly proved that the Nerve of Hearing was in existence, and in itself adequate to its function. I apprehend that the imperfection in these cases is more frequently in the neurilema or membrane which we have noticed as Pia Mater, than in the nervous matter; and that the different appearances which were observed by Cullen, Sauvage, F. Hoffmann, Arnemann, and Rosenthal in the pulp of the Labyrinth, were probably seated in that covering, instead of being in the Nerve itself. There are, however, many causes which may affect the functions of the Nerve of Hearing, independently of any disease or malformation in the structure of the Ear itself; such especially are tumours* in the neighbourhood of the Acoustic Nerve, before it arrives at the Foraminulæ in the bottom of the Foramen Auditivum Internum. These tumours may be of various kinds and figures, and so placed as to press upon the Nerve and paralyse its functions†.

* In J. and C. Bell's Anatomy, it is stated that the pressure of a tumour upon the Auditory Nerve will sometimes *improve* the hearing; but I am at a loss to conceive how this can be possible. I once saw a man, in St. George's Hospital, with enlarged lymphatic glands in his right groin, which raised the External Cutaneous Nerve, and caused extreme pain when he attempted to extend the limb. And I have seen in my own practice, that in cases of constipated bowels, the patients generally complained of *numbness* in the thighs, apparently from the pressure which the *fæces* in the colon produced on the Cutaneous Nerves. The late Lord Heathfield, who had several pounds of magnesia in the Cæcum Coli, was never without the feeling of numbness in his right thigh.—Query: how do such observations agree with those of Sir C. Bell?

† *Vide* Valsalva *de Aure Humana*.

Paralysis of the Nerve, however, may take place without the existence of any such apparent cause; and when this occurs, I am inclined to think, it may arise either from some morbific or morbid action of its nutritious vessels, or from some morbid or preternatural enlargement of the arteries which pass over it near its origin*.

In noticing the various morbid phænomena to which the Saccus Labyrinthi is liable, very little need be said; for it exists under the same circumstances as every other part belonging to the Organ of Hearing. From being an effect of secretion, it is in a state of continual change, its vessels perpetually adding new fluids and removing old ones; it is consequently liable, during every moment of life, to become changed in its nature, in the same way as every other part of the body. From the numerous cases on record, it would appear that the vessels which secrete the fluid of the Sac of the Vestibule are very much disposed to take on morbid actions; for we find it stated that the cavities of the Sac have been seen filled, sometimes with a carious† or cheesy matter‡; sometimes with blood and pus§; sometimes with calcareous concretions‖; sometimes with hydatids§; and, in old people, to be sometimes entirely empty¶. All these effects, however, are the results of disease: they are always accompanied with total deafness, generally with

* It is a curious circumstance, that all the Cerebral Nerves should have Arteries passing over them near their origins. Thus the First, Second, and Third pairs, have branches of the Cerebral Arteries; the Fourth, Fifth, Sixth, Seventh and Eighth pairs, have branches of the Basilary, and the Ninth have branches of the Vertebral Arteries, running over them, immediately on their emerging from the substance of the Brain. These circumstances are, I believe, not generally known, although they account in some measure for various morbid nervous phænomena, and for the relief which is frequently experienced from the use of the lancet and purgative medicines.

† Memoirs of the Medical Society of London, vol. iii. p. 1.

‡ Phil. Trans. vol. xci. p. 435.

§ M. Portal, *Anatomie Médicale*, tom. iv.

‖ London Medical and Physical Journal, vol. xliii. p. 519.

¶ Medico-Chir. Rev. vol. vii. p. 299.

painful affections in the Ear, and often with disturbance in the functions of the Brain. But none of these morbid states have ever been discovered to obtain in the Labyrinth of the Fœtus; and I am inclined to think, that as the circulating system in the Fœtus is less exposed to accidental disturbing causes than the Animal when it has begun to breathe, such untoward occurrences are scarcely within the sphere of possibility during the period of uterine existence.

The Tympanum.

In our Physiological observations, we stated that the machinery of the Tympanum was the medium through which the actions produced by sonorous pulses were transmitted to the Labyrinth; and in our Anatomical description, we observed that the cavity of the Tympanum was not completely developed at birth; that it was very narrow between the Membrane or Drum and its osseous Septum; that it had no Cellulæ Mastoideæ, and was, in the Fœtus, filled with a serous fluid. In investigating the causes of congenital deafness, it is of great importance to trace the processes which nature employs in building up the textures of the Tympanum; for unless we are acquainted with the circumstances of their healthy production, it is obvious that we can entertain little or no hope of being able to alleviate, or remove any of the causes of their morbid conditions, when these unfortunately occur. We are aware, however, that it is impossible to trace the Apparatus Tympani from its origin to its completion; for the organ is not only at all times very difficult to investigate, but up to the third month of fœtal life it is so imperfectly formed, as to render every attempt, prior to that period, to discover the state of its textures, a matter of the utmost difficulty. There can be no doubt of every texture being formed progressively, and with the greatest regularity; for the Primordium or Germ must, when perfect in itself and supplied with the necessary maternal elements, be endowed with the power of producing an organic machine perfect in all its parts; but the annunciation of this law gives us no idea of the manner in

which the Tympanum of the Ear is developed,—that can only be acquired by experience. Taking the third month of gestation, (in the absence of observations made at an earlier period,) we find that the Septum Tympani is composed of a very soft and highly vascular cartilaginous-like substance, and is covered with a very thin vascular membrane; that the latter forms a bag, which envelopes the whole cavity, and extends along the rudiments of the Eustachian Tube to the fauces; that that portion which forms the internal lamina of the Membrana Tympani unites, by cellular substance, with another, apparently a continuation of the Cuticle, which constitutes the external lamina; that, from the secreting vessels of these laminæ, an irregular circular canal, of about three quarters of an inch in circumference, is formed, upon the outer margin of which osseous matter is deposited, to form the Os Annulare; that this imperfect ring,—apparently the first ossific secretion belonging to the Ear,—is placed directly opposite to the Septum Tympani, and separated from it by a portion of serous fluid; and that the rudiments of the Apparatus Tympani are deposited between the drum and septum,—the bones in a cartilaginous, and the muscles in a membranous state. About the fourth month, we find the Os Annulare to be a little further removed from the Septum Tympani, particularly at its inferior and anterior parts, and the Membrana Tympani to have undergone a little change; for those parts which are attached to the Os Annulare and Manubrium Mallei are now more vascular, and apparently thicker than the remaining portion. The whole also forms a loose convex surface externally, and has the rudiments of the Ossicula Auditus lying upon it internally. At this period of life, all the parts we have mentioned are completely formed as to figure; but their substance is still entirely cartilaginous, and covered, along with the nuclei of their muscular textures, with processes of the Membrana Propria Tympani. About the fifth month, the different parts composing the apparatus of the Tympanum are found to be fully formed.

It is easy to demonstrate that the vessels by which these progressive developments are accomplished, are situated on the outer surface of the Membrana Propria Tympani; and, from their superficial situation, it may be imagined that they are more exposed to the influence of local causes of derangement than those concerned in the production of the Labyrinth; and hence, that congenital defects of hearing are much more frequently owing to malformation, or a morbid state of the apparatus of the Tympanum, than to any pathological condition of the parts composing the Labyrinth. When a part only of the apparatus of the Tympanum is deficient, that structure which is most superficial is generally the one which is the most imperfect. In almost every case of congenital deafness which has come under my notice, I have found the Membrana Tympani so defective as to induce me to regard the circumstance either as the sole, or at least as the main, cause of the deafness. The imperfections to which the membrane of the Tympanum is liable, may with some propriety be referred to two distinct causes; namely, malformation and disease. The former may arise from the secreting vessels of the part being originally incapable of fulfilling the intentions of nature, or from their taking on different and irregular actions: the latter, viz. disease, is particularly apt to follow, from some morbid peculiarity inherent in the constitution of the parents. When the Membrana Tympani is the seat of malformation, the imperfection may consist in its being either totally or partially absent*; in being attached to more of the Ossicula Auditus than one†; in being either too large‡ or too small; and in being paralytic from some faulty function or formation of its nerves. When it is the seat of disease, the affection may be owing to any of the morbid affections which we have already noticed when investigating

* *Vide* A. Landon's Case, p.109.
† *Vide* S. Fulford's Case, p. 112.
‡ *Vide* Phil. Trans. vol. iii. p. 666.

the pathology of the Labyrinth; most commonly it is due to inflammation.

When the membrane is either totally absent, or only partially formed, the whole machinery of the Tympanum is, in general, rendered totally useless; for then the parts are covered by a process of the common integuments, and bound down in such a manner as to be rendered incapable of replying to sonorous pulses, unless they are of a very powerful nature,—such as those occasioned by the report of a cannon, the ringing of large bells, &c. In such cases the handle of the Malleus is deprived of its proper attachments, being drawn inwards by the action of its different muscles, and thereby rendered unfit to convey to the adjoining bones those actions which are necessary to the sensation of sound. But these are not the only consequences of a deficiency in the Membrana Tympani; for along with this we frequently find the whole, or a part of the apparatus of the Tympanum also absent. In the absence of all experience, this is what we should have anticipated; for since the membrane of the Tympanum is formed partly from that membrane which, in the perfect Ear, covers all its textures,—and it is from the vessels of this part that every other is secreted,—it obtains when the membrane is itself deficient, that all the structures which depend on it for their growth and maintenance must be defective likewise. In all cases of imperfection of the Membrana Tympani, it may be laid down as a law, that the apparatus of the cavity is also imperfectly formed; and such being the case, that the power of responding to ordinary sonorous impressions is wanting.

When the Membrana Tympani is attached to more of the Ossicula Auditus than one, there does not appear to be any deficiency of parts, although such a state of things might doubtless exist. In the few cases which have come under my care, I have invariably found the membrane apparently entire as to extent, but faulty as to figure; and in general so connected with the long process of the Incus, as to render the Malleus entirely useless. Indeed

I am inclined to think, that in such cases the whole of the Ossicula Auditus are in the same condition as if they were anchylosed or luxated. Their muscles, it would appear, cannot then act in harmony with each other, nor in such a way as to fulfil the intentions of nature. From the handle of the Malleus being placed externally to the membrane, and having several muscular fibres from this part attached to it, near its root, it appears, however, to be susceptible of some slight degree of motion, and of producing corresponding effects; but these, when viewed in connexion with the imperfect functions of the Incus and Stapes, must be of a very confused or indefinite nature,—perhaps very similar to that sensation which we experience on pressing the point of a finger into the Meatus Externus. When congenital deafness, therefore, seems to depend on this cause, it is extremely difficult to make the patient sensible of any other than the very loudest noises; and we have then generally to lament the little relief that is obtained from any mode of treatment adopted.

When the faults of the Membrana Tympani appear to consist in its being too large, the Os Annulare must also participate in this increased size, and of course be productive of some change in the figure of the Cavitas Tympani: for since it is apparently on the correct formation of the osseous ring that the whole machinery of the Tympanum hangs,—when any defect occurs in its development, the whole of the Apparatus Tympani must be, to a certain extent, affected. It is not, however, a very common occurrence for the Membrana Tympani or the Os Annulare to be too large. In all the cases of congenital deafness which have come under my notice, I have invariably found the Os Annulare about the usual size, and the Membrana Tympani to be either entirely absent, or attached, in a preternatural manner, to the Ossicula Auditus and neighbouring hard parts.

When the Organ of Hearing is judged capable, from the apparent perfection of its structure, of conveying to the brain sensations of sound, yet gives no information of

the kind, it is said to be in a state of paralysis. When this condition has existed from birth, the cause of the deafness may commonly, with propriety, be ascribed to the existence of some imperfection, either in the form or in the substance of the Auditory Nerve, or of the Nerves of motion distributed to the muscles of the Apparatus Tympani. In such cases these muscular structures must soon become wasted, from the absence of those actions which are peculiar to their œconomy; so that in a short time all the parts of the machinery will merely possess their relative forms and positions, without any power of displaying their functions. They will resemble the withered leaf,—entire in its forms and parts, but sapless and incapable of rendering any useful action.

When the Membrana Tympani becomes morbidly changed by any primary or secondary* cause, the different structures of the Cavitas Tympani may be said to be in a diseased state; for the vessels which secrete and nourish the one, perform the same offices to the other. Now I am inclined to think, that, in these cases, the vascular system must be in a very irritable state, and consequently predisposed to inflammation, which will be apt to terminate in suppuration, ulceration, and in a variety of other unfavourable ways;—such as morbid growths, from an overabundant supply of nutritious matter; morbid wastings, from a defective supply of that matter; ossification, from the vessels displaying the functions of those appertaining to the Periosteum, &c. The most common disease, however, to which these textures are liable, is inflammation terminating in suppuration and ulceration; and when this takes place soon after birth, the matter is frequently of an ichorous nature, highly offensive to the smell, and very destructive to the locomotive machinery of the Ear. This form of disease may, in general, be said to be constitutional; for in the majority of cases which have come under my care, I have found little diffi-

* By the term primary, I mean those which owe their origin to the presence of some property of the primordium; and by secondary, those which have arisen from the mother.

culty in tracing the existence of the scrofulous diathesis, or some other hereditary morbid tendency to the parents. The purulent or ichorous discharge is generally found to have existed so long before such cases are brought under our notice, that the whole, or at least the greater part of the machinery of the Tympanum is destroyed, by which the foundation is laid of a considerable degree of deafness. In congenital cases, I am inclined, however, to think, that the discharge is seldom or never of an ichorous nature before birth; at least, in every case of the kind which has been under my notice, shortly after the period of birth, I have invariably observed that the morbid action was entirely confined to the texture which was its theatre, and that no irritation existed in its neighbourhood. It was only when the parts came in contact with the oxygen of the atmosphere, that such phænomena were developed. This peculiar change, which suppurating matter undergoes, ought to warn us that, when the organ of hearing, or of vision, exhibits any appearance of disease, no time should be lost in the administration of those remedies which have the power of alleviating or removing it.

With respect to the imperfections to which the Ossicula Auditus are liable, we may observe that they are exposed to the same changes as the other osseous textures of the body, namely, malformations and morbid alterations, which I presume may arise from the same causes as those we have already noticed. Of the malformations, the whole may be comprehended under the following divisions; viz. in being fashioned in an unusual manner, such as on too large or too small a scale*; in being only partially formed; and in being totally wanting. Of the morbid alterations, the most common are; necrosis, exostosis, and scrofula. The degree of deafness attending these morbid conditions will, doubtless, correspond with the importance of the part or parts which are their subjects, combined

* Dr. Baillie discovered the Ossicula Auditus three times less in size than ordinary; and Reimarus found them wanting altogether. *Vide* Medical and Physical Journal, vol. xliii. p. 520.

with the extent and nature of the mischief. When the Malleus or the Incus, or both, are imperfectly formed or diseased, the deafness cannot be supposed to be of so intense a nature as when the Stapes is also implicated; for then the Foramen Ovale will, in all probability, participate in the evil; and this is always a very unfortunate circumstance. From the experience of others* it appears, however, that there are some exceptions to these conclusions; for we find it stated, that a very slight alteration in the figure or composition of these bones will sometimes produce considerable deafness; and at other times the most extensive defects will occasion little or no loss of hearing. These extraordinary circumstances, however unaccountable they may be, clearly prove, if the information be correct, that the Labyrinth alone must possess the power of exhibiting functions, without the aid of an apparatus which we have been all along taught to consider as essential to their evolution. But such facts are valuable, for they admonish us that we ought seldom or never to lose confidence, or to abate in our endeavours to restore hearing to those who may have been even long afflicted with deafness†.

From what has now been said on the membranous and osseous textures of the Tympanum, very little will suffice in regard to the muscular structures of this part; for it is well known that no muscle can act without its proper attachments, and that when any defect exists in the one, a corresponding fault must exist in the other. As to the morbid phænomena to which the muscles of the Tympanum are liable, these can only be ascertained by observation and experience; for previous to death and the dis-

* In the *Journ. de Physiol. Experimentale,* there is an account of a dissection of the Ears of a boy eight years old, by Mons. Bernard, in whom all the Ossicula Auditus were wanting, and yet the boy, when alive, *heard very well.*—Query: What caused Mons. B. to dissect the Ears of this boy?

† There are many cases recorded in the different Medical and Surgical Journals, which prove what can be done by directing the will, in a proper manner, to a faulty organ of volition.

section of the parts, every idea on the subject must be hypothetical. It is, however, probable, that the most common will consist in the nutritious vessels secreting ossific, cartilaginous, carcinomatous, or some other matter, instead of the muscular. In scrofulous and other hereditary unhealthy constitutions, morbific and morbid muscular phænomena form a part of the general derangement, and these have, in general, been explained by pathological anatomists, on certain fixed principles; but these principles, which at present it is unnecessary to recite, do not enable us to form any idea of the manner or the means by which, in this peculiarity of constitution, the healthy actions of life are hindered. But to return to the Tympanum: —We may observe, that, as no two things can possibly be alike, and as no disease can exist without a cause, so it is impossible for congenital deafness to exist in any two persons from the same cause. Hence we find that every texture of the Ear is liable to its own mode of derangement; and that besides those already noticed, the Tympanum may be faulty as to its figure, the composition of its walls, the situation and form of its Foramina, or Fenestræ, &c.; and that each of these may affect the textures of the Labyrinth on the one side, and those of the Meatus Externus on the other, and be the means of producing various and considerable degrees of deafness.

When the Meatus Externus is the seat of an imperfection, this cannot, in every instance, be ascribed to congenital causes; for since the canal is progressively developed after birth, it is evident that in some cases the imperfection must be owing to causes connected with the growth of the part in question. From the osseous textures of this canal being wholly secreted after birth, it appears to me, that the only congenital malformations to which it is liable must, in a great measure, be owing to the formation of the Os Annulare. Hence we find that it is apparently sometimes too large*; sometimes too small†;

* Phil. Trans. vol. iii. p. 666.

† *Vide* G. Shreeve's case, p. 113.

sometimes divided by a membranous septum into two parts*; sometimes obliterated by a continuation of the common integuments†; and, as we advance in age, that it is sometimes contorted and replete with Pili. Among these phænomena, it is evident that the greater part must have arisen from some fault in the formation of the Os Annulare; but that the last-mentioned may be due to causes of a different nature, such as the improper use of the forceps during the birth, or the application of some hard substance over the Ear of the child, so as to give the canal a direction different from that intended by nature: for after birth, every imperfection progressively developed, can only be viewed in connexion with the general œconomy. In scrofulous constitutions, from the body being apparently more vascular than in the sound or healthy state, the secreting system does not appear to possess the power of producing the more ponderable materials in their due proportions and in their proper places; and the consequence is, the existence of a greater degree of elasticity than is consistent with its perfect development. Those parts which require a considerable time to attain completion, must necessarily be more susceptible of derangements, than those which depend on the maternal elements for their evolution,—and the result must be faulty or imperfect developments. It is very easy to apply these remarks to the development of the osseous textures of the Meatus Externus, and to some of the imperfections which it occasionally exhibits; and likewise to the effects which the faults of this canal must necessarily produce on the transmission of sound.

We have already spoken of the Cavitas Tympani being, in the fœtus, continually filled with a fluid, and have alluded to its apparent uses and to its gradual disappearance. During the uterine existence, this fluid, after the development of the cavity of the Tympanum, must be con-

* London Medical Repos. vol. xxii. p. 251.

† Medico-Chir. Trans. vol. xi. p. 331.

tinually flowing along the Eustachian Tubes, and thus keeping them constantly open; and after birth a like function must be performed by the fluid which the vessels of the Tympanum and Tubes are continually secreting. When the Eustachian Tubes happen to be impervious either from malformation or disease, the fluid must necessarily be retained in the Cavitas Tympani, and become chemically changed. The progressive secretion of new fluid within the Cavitas Tympani must also cause not only great irritation in the textures, but their separation one from another, and ultimately their absorption. In this way the foundation of congenital deafness may be readily conceived to be laid. The degree of deafness, however, which this cause produces, will probably be less severe than when the malady arises from any original deficiency of texture in the Apparatus Tympani; for in these cases some part of the drum will soon become absorbed by the pressure, and thus give an exit to the matter before it has produced much injury; and besides, the Stapes, from being more firmly fixed than the other bones, will almost invariably remain *in situ* with some of its muscles attached to it, and of course be accessible to the excitement of sonorous pulses, and capable of conveying these to the textures of the Labyrinth*.

When we investigate the structure and uses of the Eustachian Tubes, we can easily perceive that they must be very liable to disorder and disease, and consequent obstruction to their functions. As they are evidently subservient to the Tympanum, it follows that any faulty action existing in that cavity will be propagated to them, independent of the morbid phænomena to which they are liable themselves. From the passive nature of the functions of the Eustachian Tubes, we are inclined to think, when they are morbidly affected, that the cause is more frequently of a secondary than of a primary nature: and we are confirmed in this opinion, when we reflect on the functions of the vessels

* Mem. Med. Soc. Lond. vol. iii. 549; and Valsalva *de Aure Humana*.

which secrete the fluid that lubricates the Apparatus Tympani, and keeps the passage of the Eustachian Tubes constantly open; on the membrane which covers the whole; on the sympathy which exists between the two; and on the irritating effects which an unhealthy secretion produces when it runs over a healthy secreting surface:—for when the fluid in question possesses irritating properties, it must, in passing through the canals, give rise to inflammation and constriction. Indeed we are disposed to think that such a vitiated secretion is by no means an unfrequent occurrence; that when it exists for any length of time, it invariably renders the tubes impervious; and that when this event occurs, the fluid accumulates in the cavity, and produces by its pressure a fistulous sore either in the drum or in the mastoid process. When the Membrana Tympani gives way, the matter passes along the Meatus Externus, causes great irritation, and constitutes the disease commonly known by the name of the "purulent discharge of the ear." But although the Eustachian Tubes are apparently more liable to secondary than to primary morbid phænomena, there cannot exist a doubt as to their textures being occasionally the seat of idiopathic disease; for if every structure be liable to its own mode of derangement, the Eustachian Canals can form no exception to the general law, and consequently may be, in some cases, the primary cause of congenital deafness.

In our anatomical description of the Chorda Tympani, we stated that it conveyed to the machinery of the Tympanum the percipient and also the moving principles, and that it was formed in the same way and by the same means as every other nerve in the body. This relative dependence implies that its materials must be continually in action, and undergoing changes according to the laws of vitality; consequently, that the nerve must be as liable to unhealthy actions as any other texture belonging to the Ear. We can easily, therefore, conceive the probability of the Chorda Tympani being the theatre of a variety of morbid phænomena capable of causing congenital deafness. When its

secreting vessels produce a fluid, or a substance whose properties are inconsistent with its functions or its perfect formation,—derangement, and a privation of those powers which excite the various textures of the Tympanum to perform their respective functions, will be the consequence. We are, however, inclined to think, when congenital deafness is due to faults in the Apparatus Tympani, that this nerve, from its position, must also participate in the derangement; for when we investigate the evolution of any particular organ in the Embryo or Fœtus, we invariably find that the rudiments of all its textures, or parts, are progressively forming at one and the same time; and also, that when any important part appears imperfectly generated, all the others connected with it seem, as it were, to accommodate themselves to it. This law,—if it may be so termed,—is occasionally exhibited in malformations of the extremities; and it probably also obtains in regard to the Chorda Tympani, when the machinery of the Tympanum is imperfectly formed. What, indeed, would be the use of this nerve in the absence of those textures whose actions it is designed to controul? Is it not evident that the one exists for the sake of the other, and that if the Apparatus is absent the nerve would be useless?

CHAPTER IV.

THE TREATMENT OF CONGENITAL DEAFNESS.

HAVING now taken a brief view of the œconomy of the Ear, and some of the most obvious imperfections to which its textures are liable, we shall next proceed to offer a few remarks on the means which appear best calculated to alleviate or remove these faulty conditions. It must be obvious from what has been advanced in reference to the various textures composing the organ of hearing, that when congenital deafness is owing to any fault in the formation of the Labyrinth, little or no relief can be anticipated from any kind of treatment; and that it is only when the defect depends on a faulty construction of the Tympanum, that we can entertain any hope of being able to administer relief. Here I shall not pretend to notice all the remedies which have been said to be capable of removing certain kinds of deafness, but merely those which seem to have the power of producing particular general and local effects. For although our notions of the œconomy of the organs of sense are altogether relative, nevertheless it is evident that, in the production of every effect connected with, or appertaining to, the phænomena of sensation, nature uses, apparently, none but very simple measures; and that when she does not complete an important evolution, she still seems to evince a desire,—if we may be allowed so to express ourselves,—to assist it so as to arrive at the proper end. In the treatment, then, of every imperfection of the animal machine, and in particular of those of a secondary description, the operations of nature should always be solicited, by the administration of those remedies which appear to have the property of exciting the vital actions, under which these parts are developed. When the

imperfections are inconsiderable, and situated in a texture whose functions are apparently more of a passive than of an active nature, the power of production or reproduction which inheres in the body should be solicited, even although we may have little or no hope of success in our views; for though we know of no instance wherein the interposition of the productive power can be demonstrated, it is admitted on all hands that this power exists, and is one of the most important provisions of nature in securing the conservation of the individual. What is the phænomenon of secretion but an illustration of this power? and are not all the effects which the animal machine exhibits demonstrative of its inherence and activity? The productive powers of life are so uniform in their effects in the greater, and in particular during the earlier part of animal existence, that when they fail in the formation, completion, or reproduction of any texture, we can only ascribe the fault to the influence of some local or accidental cause. The power of production exists, however, in different degrees of energy in different departments of the animal kingdom. That it is very limited in man, and in those animals which seem to be nearly allied to him in organization, cannot be doubted; nevertheless it is sufficiently active to be capable of remedying the effects of certain severe injuries in every stage of life; and, but for our ignorance of its nature, and of the agents whose properties might be qualified to sustain it in its operations, we might also add, some congenital imperfections. Let us only reflect on the energies of this power as we descend in the scale of animals*: how extensive are its manifestations where mind cannot be traced, or at least nothing like reflection is evident!

* *Mémoires de l'Académie des Sciences de Paris*, 1686.—Spallanzani, *Prodromo di un Opera da imprimersi sopra le Reproduzione Animali.* —*Journ. de Physique*, 1777.—Bonnet, *Œuvres d'Histoire Naturelle*, t. 5. —Spallanzani's Tracts on the Natural History of Animals and Vegetables, vol. ii.—Leeuwenhoeck, *Epistol. ad Societatem Regiam, aliosque illustres Viros:* Leid. 1719, 4to.—*Arcana Naturæ continuata*, 4to.—Blumenbach, *Specimen Physiologiæ comparatæ inter Animalia calidi et frigidi Sanguinis*, 4to.

In every animal the machinery of the body coincides with its functions; but the life—the essence or nature—which generates and causes this machinery to perform its actions, is, in all, of one and the same nature. To what cause, then, are we to ascribe the absence of the power to complete an imperfect organ, after birth, in warm-blooded animals, and in particular in man? Before birth, when any defect occurs, we have stated that it seems to originate in some local or accidental cause:—after that event, however, the same causes cannot be supposed to operate. How, then, are we to account for the continuance of the imperfection? Can we with any kind of reason ascribe it to the presence of the mental powers, or to the complex machinery of warm-blooded animals? If we assign it to either of these causes, it necessarily follows, that the more perfect the machine is, the less perfect are its actions. The evolution of the complicated machinery of warm-blooded animals, and in particular their endowment with mental faculties, was evidently provided for some purpose; and this, according to our ideas, is to assist in maintaining the principles of self-conservation, and consequently in alleviating or removing the effects of those actions which, from some obstruction or adventitious cause, have been so imperfectly conducted as to infringe on the animal's œconomy.

What, then, let us inquire particularly, is the nature of those agents which have been placed at the disposal of the mental faculties for such important ends as the alleviation or removal of congenital deafness? We have stated, that every organ, texture and system, is the product of properties which existed in the paternal and maternal elements, and is the effect of secretion; and that when either the primary or the secondary elements were vitiated by any general or local cause, corresponding effects invariably followed. When any congenital imperfection of the Ear therefore exists, the first thing which we have to consider is, the probable cause of the phænomenon; and next, the means which, on being conveyed to the lungs and to the stomach, may appear to have the power of exciting par-

ticular secretions. As to the first, it is evident, from all having relation to the phænomena of vitality and organization, being, in the Mammalia, involved in the deepest mystery, that we can form no idea on the subject from them; it can only be by pursuing our investigations in the lower departments of life, and from the apparent effects which the administration of certain materials produce on the animal œconomy, that we can hope to arrive at any conclusion. From every action being accompanied by a certain transmutation or waste of matter, it appears that everything which has the property of supporting the animal machine must be of a stimulating nature; and that without a proper supply of alimentary matter, life cannot possess the power of evolving or regenerating any part of the body. As to the qualities of the air which is requisite to the phænomenon of healthy respiration, we are aware, from the innumerable changes to which the atmosphere is liable, and the variety of constitutions, that no general rule can be laid down on the subject; but as everything of an irritating or over-exciting nature seems to be inconsistent with health, it is evident that that air which enlivens the system and renders all the feelings agreeable, must be the most proper. In proof of this, we have only to refer to the great improvement which takes place in the health of persons, whose constitutions have been debilitated by disorder or disease, on being removed from an unhealthy and confined, to a healthy and open neighbourhood. In some cases, after every other means have been tried in vain, the benefit derived from a change of air has been such, as to have convinced the most sceptical, that we receive more nourishment from the functions of the lungs*

* Physiologists have recently denied that we receive any *nourishment* by the *lungs;* and yet they all acknowledge that the blood, in its passage through these viscera undergoes a change *essential* to the existence of life; that it depends, in fact, upon this change that nutrition and every other function is sustained.—Whatever assists life in the maintenance of its various healthy actions, is nutritious; for if it was not, these actions could not be preserved. In vegetable life, climate is everything.

than from those of the stomach. Such occurrences, however, cannot excite surprise, when we take into consideration the importance of these organs, their intimate connexion with the functions of the heart, and the fatal consequences which invariably take place when they become the theatre of disease. With regard to the means proper to secure a good digestion of the aliments received into the stomach, these can only be ascertained by experience; for what may prove beneficial to one person, may have a different effect upon another. Much important information may, however, be acquired, by observing the œconomy of the different inferior animals, in health and disease, during their various stages of life; and by comparing the structure of their digestive organs with those belonging to man: also by consulting the different authors who have investigated the subject, with a view to the improvement of the general health.

We are aware it will be said, that although we pay the utmost attention to the functions of the respiratory and digestive organs, we shall not, by these means, be able to remove the cause of a single case of congenital deafness, or in any way to alleviate the symptoms arising from a congenital deformity. To these objections we would reply, that in the primordium, or embryo, the principles of motion coincide with those of nutrition; that these are sustained by the same means from the earliest to the latest period of life; and that the only essential difference between the fœtus and the animal which breathes, consists in the mode in which the nutritive matter is conveyed to the circulating fluid. Besides, we know by experience, that every action which the animal machine displays, harmonizes with the properties of the matter which is introduced into, and becomes amalgamated with, the system; and that the phænomena of health and of disease depend, in an eminent degree, on its nature. Now this being the case, does it not obtain, that in our endeavours to alleviate or remove any congenital imperfection, the utmost attention ought at all times to be paid to the state of the secretions? But

this is not the only reason we have for attending to the due performance of the respiratory and digestive functions; for if it be by them that our existence is sustained, does it not follow as a consequence, that no benefit can be expected from any kind of medicinal means which it may be thought advisable to pursue, without at the same time paying a strict regard to them? How are we to account for those spontaneous cures of congenital deafness recorded in the Memoirs of the Academy of Sciences for 1703, page 18, and in the Philosophical Transactions, vol. xxv. page 1469, but by the principles of life becoming endowed with the power of producing parts hitherto defective? from the introduction of nutritious matter into the system, through the medium of the lungs and stomach, during that period of life when the primary properties of the blood are supposed to exist in their greatest abundance? We cannot indeed separate the functions of the organs of digestion and respiration from the treatment of any disorder or disease; and in congenital deafness they are evidently of the first importance. Let us only observe how perfect all the evolutions of vegetable life appear, when its nutritious or maternal properties are present in due quantity and quality: and did we but know what was most proper for nutrition in the animal kingdom during the different stages of life, as well as we appear to do in the vegetable, it is very probable we should, by attending to such means alone, be able to remove many faulty phænomena hitherto considered as irremediable. It is indeed from our ignorance of these great primary laws of nutrition, that we are obliged to have recourse to measures of a medicinal nature, for the cure of disease or rectification of deformity.

Medicinal remedies, in reference to the Ear, may with some propriety be divided into general or internal, and local or external. By the former we mean all those medicines which, on being conveyed to the stomach, have the power of producing certain effects on the whole system, and through this on its parts; and by the latter, all those

which, on being applied to certain textures of the Ear, immediately or in its neighbourhood, have the property of exciting the powers of life to repair or to engender parts hitherto defective. With respect to the general remedies, we may observe, that those only of a gently stimulating nature seem to be indicated; for everything of an irritating quality must prove detrimental to the actions which are requisite to the productive or reproductive phænomena of life. Those which we have found the most beneficial have in general been mildly aperient; such as the extr. colocynth. comp. or the pil. aloes comp., administered in doses coinciding with the age, sex, &c. of the patient. At all times, indeed, the bowels should be kept in a state of gentle relaxation, so as to excite the various secretions, without producing any violent action in the heart and arteries, or the absorbents. And I may here observe, that all those medicines which have the power of causing a violent action in the bowels, seem to me to be inconsistent with the œconomy of the alimentary canal; for when we consider that it is not only of considerable length, but also so convoluted as, in a manner, to demonstrate that everything which passes through it should go slowly, we must be satisfied that it is only when it becomes inactive or irregular in its functions, that purgatives can be administered with propriety.

There is another class of general remedies occasionally given with a view to the alleviation or removal of congenital deafness, viz. emetics. These agents, when carefully administered, are sometimes productive of much benefit, not only in cases of deafness, but in almost every disorder or disease; for before they act upon the stomach, they apparently produce a relaxation of all the vessels in the body; the heart and arteries gradually become less irritable, and a degree of languor seems to seize the whole system: a counteraction then sets in; the contents of the stomach, having been considerably augmented from the secretions which the stimulating properties of the emetic have excited, are shortly after ejected; and those of the

bowels frequently follow through their natural passage. Moreover, from the augmented secretion which takes place from every vessel, the whole body appears bathed in perspiration. It is not, therefore, from the mere act of vomiting that these remedies are beneficial, but from the actions which precede and succeed that event.

These, then, are the general means which, when properly administered, seem to have the power of producing certain effects, and which, we are inclined to think, should never be omitted in the treatment of congenital deafness, even although they should subsequently appear productive of no apparent benefit further than the improvement of the general health. As to the local means, these, it may be conceived, are very numerous, and, from the nature of the imperfection, often also of considerable importance; for if local defects can in any case be relieved by local applications, some of those of the ear must, it may naturally be imagined, be susceptible of improvement under such a plan of treatment. The remedies which have been found most serviceable in imperfections of the sense of hearing, consist of various kinds of stimulants, some of which are capable of being applied to the textures of the Tympanum and Meatus Externus;—such are certain preparations of ammonia, æther, the mineral and vegetable acids, and various saline substances. Others, again, are only applied to the parts adjacent to the organ of hearing. Among the local stimulants of the first class, we are inclined to think that ammonia is by far the most important: for by the judicious administration of this agent, we can often not only excite the actions of the vascular system belonging to the locomotive machinery of the Ear, but also of that of the Labyrinth, to such an extent as to render the auditory apparatus capable of performing its functions very perfectly for a time. In the different cases in which we have tried this remedy, we have found, that combining it with the linimentum camphoræ, and applying it with a camel-hair pencil to the surface of the Meatus Externus, or the Cavitas Tympani (when the membrane was absent), was

the safest and best mode of employing it. By this method we have the power of producing either a slight or a high degree of inflammation, and, of course, of suppuration; and, by occasional applications, of preserving the parts in either of these conditions as long as we may think necessary. When we produce suppuration, it should never, however, be to any great extent or degree; and during its continuance the parts should be frequently cleansed with tepid water: for in exciting this process, the only object we can have in view is, the production of a certain action in the nutritious vessels, so as to induce them to secrete, if possible, those textures which the functions of the primordium and embryo have been unable to develope; or to direct the powers of life to the faulty phænomenon, in such a manner as to cause the existing structures to act agreeably to the ordinary intentions of nature. In every degree and stage of inflammation which it may be deemed advisable to excite, one or two ounces of tepid water should be injected every day into the Meatus Externus; for by this means we both soothe the inflamed surfaces, and also remove from them all dead and irritating matter, and thereby keep up that kind of action which appears most likely to produce the effect desired. Suppuration in the textures of the Meatus Externus, or of the Cavitas Tympani, in those cases where the apparatus is wanting, is seldom or never attended with any danger to the structures of the Labyrinth, unless the process be injudiciously excited to too great a degree; for the inflammatory actions which are called up by a medicinal agent are, in their tendencies, very different from those arising from disease:—the one depends on a local, and the other on a general cause. The inflammation and suppuration which the administration of ammonia to the Cavitas Tympani ought to excite, should be gradually produced, and kept up for some time by occasional applications, during which the symptoms should be strictly attended to. It often happens that in this way, and in a short period, an obvious improvement in the hearing will be discovered to have taken place. This im-

provement, however, does not appear to arise from the completion of parts hitherto imperfectly formed, but from the actions which have been excited in the vascular system of the organ, arousing its sensibility, and perhaps also effecting the removal of all adventitious membranes or substances existing in the Cavitas Tympani,—such as the thick layer which forms the superficial covering of the cavity, and which we have described as a portion of the common integuments.

In the employment of ammonia to the surface of the Meatus, or Cavitas Tympani, we may further observe, that the actions which it produces are, in general, not of a very durable nature; for we frequently find the acuteness in the hearing which may have been produced, soon begin gradually to subside, unless the inflammatory process is occasionally excited by a fresh application. In using ammonia, some caution is also requisite; for when its strength is too great, or it is employed in too large a quantity, it will soon cause extensive suppuration, and, of course, speedily destroy a number of textures, some of which may be of considerable importance; and thus produce a greater degree of deafness than had previously existed, unless the reproductive process is subsequently excited. In scrofulous constitutions it is very apt to excite gangrene.

With respect to the second remedy of a local nature which we have mentioned, viz. æther, we may observe, that it is in importance next to ammonia; and although it has been more frequently employed in the treatment of occasional deafness than in congenital cases, it is nevertheless often capable of proving very beneficial in the latter. In every case in which I have given it a trial, I discovered that the patient could be made to hear sounds of a kind which he could not hear before. In all cases of deafness arising from any morbific action in the structures of the Tympanum, or of the Eustachian Tubes, or of the Meatus Externus,—such as a privation of the ceruminous secretion,—however, it is a remedy more decidedly useful.

Although less powerful than ammonia, æther is still

sufficiently active to produce inflammation in the textures of the Meatus Externus or Cavitas Tympani, and also suppuration when that process is deemed necessary. It has the advantage over ammonia of being applicable in every kind of constitution; for I never could discover that it did harm. Indeed I may observe, that whoever gives this remedy a fair trial, and administers it in a proper manner, will entertain no doubt of its efficacy in almost all cases of deafness.

On the use of the mineral and vegetable acids very little need be said. In a concentrated form they are evidently inadmissible: it is only in the diluted state that they can be used with any degree of safety or benefit; and we may also add, that they should only be employed after the ammonia and the æther have had a fair but unsuccessful trial.

The saline substances which have the power of exciting an increased action in the vessels of the Meatus Externus and Tympanum, and thus giving rise to inflammation, or some other phænomenon similar to it in character, are, the nitrate of silver, the sulphates of copper and zinc, &c. These substances, when judiciously applied, are highly beneficial in the treatment of all chronic inflammatory diseases of the Tympanum and Meatus Externus; and in particular in those which terminate in suppuration, and produce the disease commonly called "the puriform discharge, or the fungous excrescence of the ear;" for they seem to have the power not only of destroying the morbid actions of the nutritious vessels, but also of exciting them to perform functions of an opposite or healthy kind. This being the case, they appear to me to merit a trial in various cases of congenital deafness; but I have not yet had such opportunities of trying their efficacy, in the class of cases to which I believe them most applicable, as will enable me to speak confidently of the extent of their utility.

Besides the remedies already noticed, all of which require, in their application, to be continued for some months before a beneficial result can be expected, there are others which appear to have the power of producing a

certain degree of excitement in the secreting vessels of the Ear, and are almost constantly employed in the treatment of deafness. These comprise various substances, which can only be applied to parts contiguous to, but not directly connected with, the organ of hearing;—such are rubefacients and errhines. Of the former, blisters may be regarded as the principal; and what we can venture to state on the nature of their actions and extent of their utility, may, with very little exception, be applied to the rest of that class of remedies. By the application of blisters to the surface nearest the origin of the Acoustic Nerve, viz. the nape of the neck, or behind the auricle, we increase the actions of the vascular system in the textures over which they are placed, and at the same time excite the functions of the auditory, and almost all other nerves in a very extraordinary manner. In congenital deafness, as well as in several other diseases of the Ear, the benefits derived from the employment of a succession of blisters to the nape of the neck, are often found to be considerable; but the *modus operandi* of these remedies does not appear to be properly understood, or their effects to be fully appreciated. In the cases in which I have given them a trial, they seemed to act upon the organ of hearing sometimes through the medium of the functions of the brain and nerves, sometimes through those of the heart and arteries, and sometimes through the intervention of the secreting system. But act as they may, it is nevertheless certain, that, in all kinds of deafness blisters are a safe and important remedy.

With regard to errhines, the pulv. flor. sambuci and pulv. asari comp. are apparently the most efficacious, and are occasionally employed in the treatment of deafness arising from various causes: but the little experience which I have had in their employment does not allow me to venture an opinion as to the extent of their usefulness; and I merely notice them because they have been classed among the remedies for the treatment of auricular diseases. It is very obvious that they can scarcely

be expected to have any power over the causes of congenital deafness, and that it is only when the Eustachian Tubes are the parts affected, that they can be productive of any benefit.

From all that has been hitherto stated, it does not however appear that we know of any agent or class of agents which have the power of exciting the principles of life to develope those textures whose absence is the cause of congenital deafness. For, although we pay the strictest attention to the functions of the respiratory and digestive viscera, and excite all the phænomena which the different medicinal agents are capable of producing, we shall still, perhaps, invariably fail in arousing the powers of life to generate the structures in question. Nevertheless, we have reason to think, from the spontaneous cures recorded to have taken place at particular stages of life, that the vital principle in those parts is susceptible of peculiar excitement, and that if it does not generate structures hitherto defective, it can, at least, produce such a revolution in the textures that exist, as to make them subservient to the original intentions of their formation. Ought we not then to endeavour, by every means in our power, to solicit such fortunate issues? And supposing all the means which we have ventured to notice, fail in producing the evolutions which we so much desire, are we altogether without resources, or have we not still other means, by the employment of which, the severity of the deafness may at least be alleviated? When we reflect on the œconomy of the eye, and on the benefits derived from the mere use of glasses, does it not appear possible that dullness of hearing, and some cases of deafness, may be relieved by the employment of an acoustic apparatus? When we refer to the various cases which have been recorded of extensive injuries having been done to the Apparatus Tympani, without producing much deafness, does it not appear that so long as the Tympanum possesses a texture in communication with the Labyrinth, and that texture has the principles of sensitive motion, it must have

the power of communicating effects capable of exciting a sensation? That such a sensation can be perfect, no one will for a moment suppose; but limited or imperfect as it may be, it clearly demonstrates that the peculiar phænomena of hearing can be excited without the presence of an apparatus complete in all its parts, and that the acuteness of the sense may probably be increased by certain remedies of a mechanical nature. In this idea we are confirmed, when we consider the relief derived from the mere introduction of a little lint into the Meatus Externus, in those cases where the Membrana Tympani has been ruptured or destroyed by violence or disease. So great indeed is the improvement which takes place from the application of this simple remedy, that patients will frequently appear astonished on being so suddenly and so easily relieved.

If we admit that the application of an external agent to the susceptible surface of a locomotive machine, can put it in motion, and that this motion, on being conveyed to the sentient part of the organ, can produce the function required,—ought we not to endeavour to establish the link which connects the external with the internal agent, when that link is absent? I am aware that the introduction of any kind of locomotive machinery into the Cavitas Tympani, in lieu of the natural, is not only a novel idea, but one of extreme difficulty to make efficient; and which, in the absence of experience, will, perhaps, appear to be visionary as well as impracticable. But we have only to consider the œconomy of the eye, and view it in connexion with the telescope, to be convinced of the feasibleness of such an apparatus, and of the possibility of introducing it into the cavity in question. With the aid of a glass, the eye is made to see objects at a distance far beyond the common range of its operations: and when the relative dependence of its different textures is destroyed by the extraction of the crystalline lens, the organ is again rendered subservient to the intentions of nature by a mechanical remedy. But perhaps it will be said that

the analogy we are endeavouring to establish is constrained; because the sight can only be improved by a glass when the eye has been perfectly formed; whereas congenital deafness depends on the non-existence of some important texture or function which acoustic machinery cannot supply. But this objection, however plausible *à priori* it may appear, has no foundation in reality; for since the sonorous properties are less subtile, and therefore more gross than the luminous, they are endowed with the power of moving certain substances with greater facility, whether they belong to the Cavitas Tympani, and constitute either a whole or only a part of its apparatus, or not, as we can perceive in those cases in which portions of the Membrana Tympani, or one or more of the Ossicula Auditus have been destroyed by violence or disease; and in inanimate matter, which may exist under certain circumstances,—such as the chords of a musical instrument shaking to the sonorous properties or pulses of another that may happen to be in the same harmonic proportion. The œconomy of the Ear is as different from that of the Eye, as are the peculiar properties which have the power of severally exciting them; and from the former being more concerned with our well-being, nature has endowed it with more extensive powers, and thereby enabled it to evolve effects without the presence of a perfect apparatus.

We are aware that the relief which acoustic machinery may have the power of affording to the Ear, will be very limited; and that its employment will, in some cases, be impracticable; but limited as the relief may be, and in general inapplicable as it may be presumed, can it be held a matter of no moment, to excite even in a single case some degree of hearing, and bestow a corresponding extent of speech on an individual who has been, during the whole period of his by-past life, a total stranger to either? When the machinery of the Tympanum is absent, or only partially present, the mechanical or muscular actions which are requisite to produce that regular chain of consequences which belongs to the phænomena of sensation, is wanting;

and until this be formed, no such effect can take place. The object, we are disposed to think, may, in some measure, be accomplished by the means which we have ventured to propose. But it may be asked:—how are we to know when this machinery is absent, or only partially present? From everything being placed beyond the reach of our organs of vision, and every texture being extremely delicate, it is evident that our information must be frequently very limited, and at all times difficult to acquire. The means which we have found best adapted to gain the intelligence we seek, consist of a musical tuning-fork, a soft plaster bougie, and a probe. By applying the tuning-fork over the skin which covers the mastoid process, we can readily discover the seat of the imperfection; for if the patient signifies that he hears the sound of the instrument, it follows that the structures and formation of the Labyrinth are perfect, and that those of the Tympanum are faulty, and *vice versâ*. By introducing the extremity of the bougie (having previously made it as soft as butter in summer), through the Meatus, and pressing it gently for two or three seconds against the textures it may meet with in the Tympanum, and then withdrawing it, we can form some idea, on taking a model of the impression with Paris plaster, of the state in which the Apparatus Tympani exists*. Sometimes, however, the canal to the Tympanum will be so narrow or contorted, as to prevent the bougie from being used; and in these cases the cavity can only be imperfectly explored by the probe. In using this latter instrument, care must be taken not to injure any of the structures; for it must ever be remembered that they are extremely delicate, and unable to bear much pressure from a hard substance. The same remarks, nearly, are applicable to the bougie; for if it be pressed with too

* The bougie which I have found best adapted for taking the impression of such delicate textures, is composed of a small quantity of shoemaker's wax, lard, and raw silk, mixed together, and fixed to the open extremity of an elastic gum catheter, in such a way as to make a soft obtuse point of above half an inch in length.

much force, or kept too long in contact with the textures it may meet with, it will, in all probability, remove them from their relative positions, and thus cause an irreparable injury.

In investigating the causes of the various phænomena of life, and in particular of those which are performed in an imperfect manner, it is of importance to acquire a knowledge of every circumstance connected with the machine by which they are accomplished. This inquiry should include the whole period of the individual's existence, and even extend to that of the parents. In congenital deafness, after the necessary examination which we have noticed has been made, we should inquire into the state of the organs of hearing at birth; whether any discharge or disease appeared in them; whether the mother had been delivered with the assistance of the lever or forceps; whether the cries of the infant had been remarked as different from those of others; whether the general health had been from that period invariably good; whether any disease existed in the family, or any siphilitic affection had, at any time, appeared in either of the parents,—and so on. By instituting so rigorous an inquiry, a general idea of the cause of the imperfection of the sense may, in many cases, be formed, and much light thrown on the pathology and principles of treatment of the affection.

The following Cases will serve to illustrate the efficacy of some of the remedies which have been noticed when speaking of the treatment of congenital deafness.

Case 1. Sarah Fulford, ætat. 10, of No. 8, Great Swan-alley, Coleman-street, a girl of a good but delicate constitution, and apparently free from all hereditary complaints. —At birth she was observed to cry very indistinctly, and afterwards, when asleep, no noise could awake her. Little attention was paid to these circumstances until she was nearly two years old, when she was discovered to be deaf and dumb, and in that state she has continued ever since.

To-day, March 10, 1828, she was placed under my care. I learned that she could hear the sound of a bell when rung close to her, and that with great difficulty she could articulate several words, such as father, mother, beer, &c., which she had learnt from the motions of the lips of others.

On examining the Meatus of each Ear, there appeared to be a plentiful secretion of wax, and the Membrana Tympani seemed to be entire, but apparently more concave than usual. On introducing the soft bougie, however, I found that although the membrane appeared perfect to the eye, it was very much malformed; that the handle of the Malleus was external to it, and attached to the Incus instead of the Malleus. The right Ear was still more malformed, and more insensible to sound than the left. Considering the case to be capable of relief, I explained to the parents the importance of her living in a pure air, and having her digestive organs strictly attended to.—Ordered a perpetual blister to the nape of the neck, and a mild aperient pill* to be taken every night.

March 17. Hearing and speech a little improved: syringed both Ears with tepid water, and plugged them with lint moistened in linimentum camphoræ.—Ordered the former remedies to be continued.

March 24. Hearing and speech continuing to improve; and she now notices and articulates the simpler sounds with facility. Was told, that since she began to improve, she has evinced a great desire to learn to read, and that she can now repeat many of the letters of the alphabet.—Ordered all the remedies to be continued.

March 31. Speech greatly improved; can now ask for various articles, and execute errands with some facility. Hearing also improved, but apparently not so much as the speech. General health considerably better.—Ordered all the remedies to be continued.

April 14. Hearing and speech continuing to improve;

* ℞. Aloes Spic. Extr. Saponis āā ʒfs. Hydr. Submur. gr. iv. ℳ ft. massa in pilulas xij. æquales dividenda. Pilulæ. Sumatur una vel duæ omni nocte hora somni.

can now hear what is said, but is unable to make a reply,—evidently showing the speech to be in its infancy. Was told that she pays more attention to the conversation of children than adults.—Applied a few drops of æther rectificatus to each Tympanum, which excited much pain. Ordered all the former remedies to be continued.

April 20. Hearing and speech progressively improving; and I was told to-day that she had heard the music of an organ in the street, apparently for the first time, which delighted her much.—Syringed each Ear, and brought away a quantity of adventitious membrane. Ordered all the remedies to be continued.

April 27. Hearing and speech considerably improved; can hear better with the right Ear than the left. Removed from the former, by the syringe, a quantity of membrane. —Ordered all the remedies to be continued.

May 11. Hearing and speech improving. Omitted the æther, and applied a little tinct. cantharidis instead.—Ordered the other remedies to be continued.

May 18. Continuing to improve. Ordered the blister to be healed.

May 22. Continuing to improve.

At every visit after this period she displayed a progressive improvement in her hearing, speech, and general health; and in a short time she appeared to require nothing more than a teacher.

N.B. Some time after this patient ceased her attendance on me, her parents, from being poor and having a family of young children, obtained an admission for her into the Deaf and Dumb Asylum, Kent Road, although she was not a very fit object for the institution. There she remained for some time, but was subsequently sent home, and died of pneumonia. From not hearing of her death till some months after it had occurred, I had no opportunity of examining the state of the Ears by dissection.

As this was the second case in which I had followed up the mode of treatment I have recommended, and the first in which its utility was strikingly demonstrated, I had

her examined by several medical gentlemen in London, all of whom were convinced of its importance.

Case 2. Anna Landon, ætat. 10, of No. 4, Cow-court, Rotherhithe, a girl of an excellent constitution, and free from all hereditary complaints. Totally deaf (in the ordinary acceptation of the word, though she can hear the sound of a large bell,) and dumb from birth.—On examining both Ears, I discovered that the Apparatus and Membrana Tympani of each were entirely absent.

February 11, 1828. Having syringed the Ears with tepid water, and brought away a small quantity of indurated wax, I plugged them with lint moistened in linim. camphoræ.—Ordered a perpetual blister to the nape of the neck, and a mild aperient pill (the same as Fulford's) to be taken every night. Gave her parents the necessary directions respecting her general health.

February 25. The hearing is very little improved; can only hear the noise of the coaches which pass her in the street.—Ordered the remedies to be continued.

March 10. No improvement perceptible in either hearing or speech. The general health, however, appears better.

March 24. No improvement. Passed a sharp instrument through the integuments covering the Septum Tympani of the Left Ear. Poured a little tincture of cantharides into each, and plugged them with lint.—Ordered the other remedies to be continued.

March 31. Hearing a little improved; can now hear a knock at the door. Hears better with the Left Ear than the Right: on removing from both a quantity of adventitious membrane with the syringe, she immediately signified that she heard much better. Punctured the integuments of the Septum Tympani of the Right Ear in the same way as the Left, and ordered all the other remedies to be continued.

April 14. No improvement perceptible. Syringed both Ears, and brought away from each a quantity of membrane. Observed that the injected water passed through the right Eustachian tube to the nose. Applied a little

æther rectif. to the Left Ear, which caused great pain, and a little tinct. canthar. to the Right, and plugged both with lint. Ordered the linim. camph., blister and pill, to be continued.

April 27. Hearing a little improved. Applied a little acid. nitr. with a camel-hair pencil over the integuments covering the Fenestra Ovalis of the Left Ear.

May 4. Hearing improved. Observed a slight discharge of matter from the Left Ear. Syringed both with tepid water, and ordered the remedies to be continued.

May 11. The Right Ear a little improved, and the Left exceedingly deaf. Removed from the Right a large portion of thick membrane with the syringe, poured into it a little tinct. canthar. Omitted the nitric acid, and plugged both ears with lint. Ordered all the other remedies to be continued.

June 15. Hearing very little improved;—hears as well with one Ear as with the other. No discharge from the Left. Poured into each a little æther rectif., which caused great pain.

June 23. No improvement perceptible: and from the great distance she had to walk every visit, together with the little benefit she appeared to derive from the treatment, she subsequently gave up attendance. It was, indeed, a hopeless case from the beginning.

Case 3. George Shreeve, ætat. 17, a young man of a strong constitution, and free from all complaint: has been in the Deaf and Dumb Asylum, and is now apprenticed to a tailor. Can articulate some words which he has learnt from the motion of the lips of others, but so indistinctly that no one, except those who are accustomed to his noise, can understand him. At present (May 26, 1828,) he is so deaf as to be unable to hear any sound, except that which proceeds from the ringing of large bells, &c. On applying a watch over the skin covering the mastoid process, he seemed wholly unconscious of its sound; but on using the tuning-fork he immediately signified that he could hear. Found the Meatus of each Ear much con-

tracted, and covered abundantly with pili and cerumen. Syringed both with tepid water, and removed from the Left a large quantity of wax. Examined each Tympanum with a probe (the Meatus being too small to admit the bougie), and discovered the existence of considerable malformations,—all the Apparatus of the Cavity being wanting.

Considering the case as hopeless, I merely gave the necessary directions respecting his general health; ordered an aperient pill* to be taken every night, and plugged each Meatus with lint moistened in the tincture of cantharides.

May 28. No improvement. Dropped into each Meatus a little æther rectif., which caused great pain, and plugged them with lint. Ordered a perpetual blister to the nape of the neck, and a little linim. camphoræ to be poured into each Ear every night.

June 1. No improvement. Left Ear suppurating, and each Meatus much inflamed: removed a quantity of membrane with the syringe. Omitted the æther, and ordered the other remedies to be continued.

June 3. Hearing very little improved. Dropped into each Ear a little tinct. canthar., and plugged them with lint.

June 8. Hearing a little improved. Left Ear inflamed, and part of the lining of the Meatus ulcerated. Syringed both with tepid water. Dropped into the Right Ear a little æther rectif., and into the Left a little tinct. canthar. Ordered the other remedies to be continued.

June 10. Hearing continues to improve; can now distinguish several sounds; hears better with the Right Ear than the Left. Each Meatus inflamed. Removed some membrane with the syringe. Dropped into each Ear a little æther rectif., and plugged them with lint.

June 18 and 22. Symptoms as before.

July 2. Hearing continues to improve; hears better with the Left Ear than with the Right.

* ℞. Extracti Colocynth. Comp.—Saponis āā ʒſs—Hydr. Submur. gr. vj. ℳ ft. Massa in Pil. xij æquales dividenda, de qua capiat i—ij, omni nocte.

July 11. Hearing improved; hears as well with one Ear as the other.

August 12. No improvement since last visit. Has been in the country during the interval, and neglected all the remedies. Renewed the former treatment.

August 14. Hearing has begun again to improve. Poured into each ear some liquor volatil. cornu cervi, and plugged them with lint.

August 16. Hearing and speech improved. Dropped into each Ear a little liquor ammoniæ, which caused great pain: plugged them with lint.

August 19. Hearing much more difficult. Observed a copious discharge of matter from each Meatus. Syringed both with tepid water, and plugged them with dry lint. Omitted the ammonia.

August 30. Hearing much improved. Observed a little suppuration from either Tympanum. Syringed both, and applied to each a liniment composed of one part of liq. volat. c. c. and four of linim. camphoræ.

September 20. Hearing continues to improve.

After this date he discontinued his visits, in consequence of his master complaining of his loss of time; and I have heard nothing of him since.

Case 4. Señor Antonio E., a native of Barcelona, ætat. 18, deaf and dumb from birth. When about nine years old he was put under the different medical practitioners of his native place, in the hope of obtaining his hearing; but after three years attendance, his case was by all pronounced hopeless. On examining the Tympanum of each Ear, I perceived that there had been originally no malformation, but that the membrane or drum was now entirely destroyed. This defect appeared to have been produced by the different kinds of treatment which his medical attendants had pursued. He is now (Christmas, 1828,) more deaf than any one I have ever seen; for he can scarcely hear any sound, even although the sonorous body be placed in contact with the skin covering the mastoid process. There appears, however, to exist a sensibility sufficient to

allow the conclusion that the textures of the Labyrinth are entire. Syringed both Ears with tepid water, and applied to each a small quantity of linim. camphoræ cum liq. volat. cornu cervi, and plugged them with lint. Ordered the liniment to be repeated every night, and to take an aperient pill occasionally, to solicit the secretions.

January 22, 1829. No improvement. Observed the Meatus of each Ear to be inflamed; poured into each a little æther rectif., and plugged them with lint. Signified that the æther had gone into his throat, and that he felt great pain.

February 3. No improvement. Applied to each Tympanum a few drops of liq. ammon. fort., which caused severe pain. Ordered the linim. camph. cum liq. volat. c. c. to be repeated every night.

February 18. No improvement. Repeated the former applications.

Shortly after this period he determined to discontinue the treatment; but in about three months afterwards, one of his family called, and stated that his hearing was apparently a little changed, for that he had applied a hearing-trumpet to his Ears; and signified that he could hear sounds which he never could before. The case, however, appearing to me hopeless, I did not give any encouragement to renew the treatment.

It is unnecessary to recite any more cases of congenital deafness to show how much the symptoms of this afflicting malady may, in some instances, be alleviated. To aid nature in producing evolutions coinciding with those performed by perfect organic machines by the agency of stimulating substances, appears to me the only safe and rational mode of treating these cases. Indeed we have only to take the first, especially, of the cases we have related, and the two to which we have referred, as illustrative of the powers of life to render imperfect organs useful without the administration of any means for that specific

purpose as our guide. For in the one which is recorded in the Phil. Trans. vol. xxv. p. 1469, we find that the individual, in the 17th year of his age, obtained his hearing and speech when recovering from a fever;—and in the other, which is recorded in the Memoirs of the Academy of Sciences for 1703, p. 18, and in Buffon's *Histoire Naturelle*, tom. iii. p. 348, we find that the young man, aged 24, obtained his hearing and speech merely from the left ear having accidentally become the seat of inflammation, which terminated in suppuration. As long, therefore, as we endeavour to solicit actions of the same nature as in these cases, we cannot do injury, and may possibly effect much good. When our efforts to afford relief succeed, it demonstrates the correctness of our views of the nature of the case, and our knowledge of the animal œconomy; and when they fail, it proves that our notions were either hypothetical as they regard the disposition of the organ and the choice and use of the remedies, or that the defect was beyond their reach; but by no means that it was impossible to alleviate or remove them.

CHAPTER V.

DISEASES OF THE EAR.

THE diseases of the Organ of Hearing have long been considered as a class of affections extremely difficult to alleviate or remove, and but few well-directed attempts have hitherto been made to investigate their nature or to devise a rational plan of treatment. This has doubtless arisen from all the important parts of the ear having been placed beyond the reach of examination in the living body, and from the few opportunities which scientific inquirers have, in general, of dissecting the parts after death. Indeed the obstacles which frequently oppose our investigations,—and these, too, in quarters where such opposition could never have been expected,—are such as to make it a matter of surprise that we know anything on the subject. But although we do not as yet possess the power of illustrating by an extensive series of morbid preparations the different diseases of the ear, it is evident, if our remarks on congenital deafness be correct, that they are as susceptible of relief as those of the eye, or any other complex organ in the body; and that we should never think of pronouncing any case, where extensive injury has not apparently taken place, to be incurable, before every means which may appear to have the power of exciting healthy actions have been tried. Indeed, I have only to refer to the various cases which are inserted in my note-book, with the observations they gave rise to, to be convinced that deafness or dulness of hearing is, in general, a curable disease; and that very simple remedies are sometimes capable of affording the desired relief. In proof of which I need only adduce as examples the first five cases that occur.

Case 1. Mrs. B., aged 25 years, a woman of a good con-

stitution, caught a severe cold, which brought on an acute pain in the Right Ear. Shortly afterwards, a discharge of matter was observed issuing from the Meatus, and in the course of ten days a fungous excrescence, extremely painful to the touch, began to appear. For this affection she took a great quantity of medicine from several medical men, without deriving any relief. Six months afterwards she applied to me. On examining the fungus, it appeared to take its origin from the Meatus near the Membrana Tympani, and to be very vascular and painful. She complains of pains darting from one Ear across to the other, which deprive her of sleep; has no appetite, and is evidently in bad health. Considering the case as capable of almost instant relief, I immediately removed the fungus with the forceps, and applied the argent. nitrat. to the bleeding roots; ordered her a mild aperient pill, to be taken every night, and to have the caustic repeated at intervals of two or three days for a fortnight, at the same time forbidding her the use of wines or spirituous liquors. From this simple mode of treatment the diseased surface soon healed; and the discharge, together with the painful symptoms, gradually disappeared. In about a month afterwards, however, the Meatus began to contract so much as to threaten an obliteration of the canal, which obliged her to apply to me again. On applying the argent. nitrat. for the removal of the constriction, I discovered that instead of diminishing, it seemed gradually on the increase. I therefore gave up the nitrate, and applied a little kali purum on the point of a camel-hair pencil to the narrowest part, and in a short time the stricture was completely removed.

A few months after the Meatus had got well she applied again, complaining of her Right Ear continuing very deaf, and without any apparent cause. On examining it, I discovered that the whole of the Apparatus Tympani, except the Stapes, was wanting; and consequently merely ordered her to pay the utmost attention to her respiratory and digestive organs, to take a mild aperient pill every

night, and to wear a little lint continually in the Meatus of the deaf Ear. These injunctions were strictly attended to, and in six months her hearing was considerably improved.

Case 2. A poor woman, aged 65, came to me with a fungous excrescence growing out of the Meatus of the Right Ear, accompanied with a purulent discharge. She told me that the disease had existed for many years, and had resisted all the remedies which several medical gentlemen had applied; and also that she was very deaf. I immediately applied the argent. nitrat. to the fungus, (for she would not allow it to be removed by the forceps); and to the Meatus of the Left Ear a liniment composed of linim. camphoræ f. ℥j, liquor. volat. c. c. f. ʒjfs. These remedies I ordered to be repeated every day, at the same time prescribing for her a mild aperient pill to be taken every night, and enjoining the strictest attention to her general health.

By pursuing this mode of treatment for two months she recovered her hearing entirely, and exhibited no symptoms of disease.

N.B. Many cases of the above description could be recited; but these two are enough to demonstrate the simplicity of the treatment followed, and the benefit derived from it and a strict attention to the general health.

Case 3. A male child, aged 3 years, was brought to me with an extensive erysipelatous inflammation of the Auricle and Meatus of each Ear, attended with much deafness, and the discharge of a thin ichorous matter from the whole inflamed surfaces. The general health was a little affected. —I ordered a perpetual blister to the nape of the neck, the inflamed surfaces to be bathed with tepid water two or three times a day, and to take ten grains of pulv. jalapæ comp. every night and morning, and farinaceous food in preference to any other aliment. By pursuing this mode of treatment for two months the child got quite well.

Case 4. A gentleman, aged 32 years, of a good constitution, came under my care for a most violent erysipelatous inflammation in each Auricle, which affected his hearing greatly. I ordered twenty leeches to the inflamed

surfaces, five grains of blue pill internally every night, and a saline draught every morning. In a week he appeared a little better, but not to the extent which I had anticipated, and I therefore ordered all the remedies to be repeated.

In a week afterwards I saw him again, and found him no better. I then ordered a perpetual blister to the nape of the neck, and the pills and draughts to be continued as before. From this time he gradually recovered, and in two months he appeared almost well.

In about a year afterwards the inflammation returned, and threatened to be as severe as before. I ordered him to recommence his former treatment, and to continue the blister, pills, and draughts, for six months after all the symptoms had left him;—and by so doing he recovered, and has remained well ever since.

Erysipelatous inflammation of the Auricle and Meatus is, I am inclined to think, from the many cases which have been under my care, a very common and difficult disease to remove; for I have frequently found it necessary to continue all the remedies, and in particular the blister, for twelve and eighteen months after every symptom had apparently ceased, otherwise I was sure to have my patient again on my hands in the course of a few months.

Case 5. Mr. B., ætat. 30, of a delicate constitution, consulted me on account of being troubled with various kinds of noises in his ears. These he told me were always more severe during the night when in bed, than during the day, and never ceased for more than five minutes at a time. He informed me further, that when the noises ceased, they did so suddenly, and returned in like manner; that when he swallowed his saliva or yawned, he either stopped the noise in one or both ears for a few minutes, or changed its character; and that the sounds were often so loud, that

he could not hear when a cart or carriage was driving past him. On examining the Meatus of each Ear, there did not appear the least secretion of wax,—but nothing else of a disordered nature could be discovered.

Considering the phænomena which he complained of to be owing to this want of cerumen, and to some faulty function of the secreting vessels of the Labyrinth and Tympanum, producing a sympathetic constriction of the Eustachian Tubes, I directed him to take five grains of blue pill, combined with a quarter of a grain of opium, three times a day, until his gums became affected; to keep the Meatus of each Ear continually plugged with lint moistened in linimentum camphoræ cum liq. volat. c. c., and to apply a perpetual blister to the nape of the neck.

In the course of a week he appeared a little, but not to any great extent, better. He complained of the pills producing great pain in his bowels, and of his mouth being a little sore. I ordered the pills to be discontinued; and as his mouth did not appear to be much affected, directed him, instead, to rub in two drachms of the unguent. hydr. fort. every night. I also punctured the drum of each Ear, and recommended the other remedies to be continued.

In the course of another week his mouth became affected, but the noises in the Ears still annoyed him much, although greatly diminished.—I discontinued the ointment, and prescribed a little aperient medicine, combined with infus. rosæ, and sulph. quininæ, three times a day.

In the course of ten days his mouth got nearly well, his general health became much improved, and the noises in the Ears had almost entirely ceased. Ordered him to continue the quinine, to omit the aperient, and to take five grains of blue pill every night for a week, then every other night for a month. At the expiration of this period his general health seemed to have undergone a complete revolution, and his hearing became quite restored.

Another case similar to the above came under my care about the same time. The same mode of treatment, except the puncturing of the drums, was pursued for three months; but the result was not so flattering. The noises at the time the remedies were discontinued had considerably diminished; but they soon afterwards began to return, and before long they became as bad as ever.

The phænomena of preternatural noises in the Ear have frequently attracted the notice of medical men, and have been ascribed by them to various causes: such as indigestion*; worms in the intestines†; inspissated wax in the meatus externus‡; obstructions in the eustachian tubes§; organic diseases in the brain and spinal marrow near the origin of the auditory nerves‖; tumours pressing on these nerves; ossification of their membranous coverings; scrofula; siphilis; fulness of the blood-vessels¶; and sometimes to disorder under the vague term of nervous**. But this enumeration, though far from being complete, is merely a list of conjectures of little or no importance; for every phænomenon connected with the Ear is the effect of secretion. When this, therefore, is faulty, either in quality or quantity, or both, the function of the organ must suffer with it, and continue until it is improved or restored to health.

In the treatment of Case 5, it will be observed, that the operation of puncturing the Membrana Tympani was performed. This I was induced to do in consequence of the manner in which it has been recommended by a modern

* Bell's Anatomy. † Hoffmann, *Med. Consult.* Boerhaave.

‡ Swan's Prize Essay on the Ear, in the Library of the Royal College of Surgeons, London.

§ Dr. Sims's Observ.: Med. Comment. vol. iii. p. 52.

‖ Journ. of Science and Art, vol. ii. p. 6.

¶ Portal, *Anatomie Médicale.* Callisen, *Syst. Chirurg. Hodiern.* tom. ii. par. 359. & 551.

** Heberden's Comment.: Phil. Trans. vol. xc. p. 151.

authority* in cases of obstruction of the Eustachian Tubes: but it was not productive of any beneficial result, for the noises were as troublesome after as before the operation. This, I confess, was what I anticipated; but as the operation was attended with no danger, I thought it not unadvisable to give it a trial.

Connected with the phænomena of unnatural noises, may be noticed the sensation of a singing or ringing in the Ears, which almost every one has occasionally experienced during a severe cold, and after a violent blow on the Ear. This phænomenon is, I am inclined to think, analogous to that sensation which we sometimes experience when sitting with one leg thrown over the other, to which we give the name of sleeping; or when we accidentally strike the olecranon against a hard body, and press violently the ulnar nerve. When it is produced either from a cold or a blow, it is very seldom known to give rise to unpleasant effects; for the singing in general subsides in a very short time, without the employment of any remedy; but when it occurs frequently, without any apparent cause, it is almost invariably the prelude to deafness. But this is what we should, even in the absence of experience, have anticipated; for when we reflect on the functions of the Chorda Tympani, and on the circumstance of its substance being continually undergoing changes according to the laws of existence, we can readily perceive that it is as liable to be the theatre of morbific or morbid actions, as any other texture of the Ear; and that it may be frequently concerned in the evolution of those phænomena called nervous disorders. When it is the seat of disordered functions, its nutritious arteries are, in general, in a very irritable state, secreting fluids inimical to health, and subversive of the harmony which pervades the whole organ. Now this disposition of the vascular system very much prevails in delicate constitutions; and when it exists beyond a certain degree, it lays the foundation for a variety of nervous dis-

* Sir A. Cooper.

orders. How often do we perceive irritable or nervous females placing their hands over their ears when any noise happens to be near them? And also desiring their servants, when they address or reply to them, not to speak so loud, because they cannot hear a single word which they say, from the painful confusion of sounds which their loud voices produce in their ears. But there is another state in which the texture of the Chorda Tympani may exist. Instead of being morbidly excited, it may be morbidly torpid; its nutritious arteries, instead of being in an irritable state, may be either diseased, or in such a feeble condition as to be unable to provide the requisite supply for the maintenance of vigorous action. This condition of the vessels is frequently met with in the after periods of life, and in those persons who are afflicted with hepatic diseases; for in the former the vascular system is generally in a very ossified or diseased state; and in the latter the constituents (probably the hydrogen) of the bile on being conveyed to the blood, acts on the various secreting vessels, and produces universal lethargy and disorder. Hence the cause of aged people, and of those who have liver complaints, being so drowsy, and so much afflicted with dulness of hearing. But in this disordered state of the secreting system, the Chorda Tympani is not the only texture which is affected; for the whole Apparatus Tympani, and the different structures of the Labyrinth, must also participate, and thus occasion an almost total privation of function.

With respect to the treatment of these phænomena very little need be said. Our object, of course, is to solicit healthy secretions, and these we are inclined to think may be procured by the due exhibition of those agents which we have recommended in the treatment of congenital deafness. We shall therefore proceed to the consideration of the faulty phænomena to which the textures of the Eustachian Tubes are liable, and the means which should be employed for their alleviation or removal.

Imperfections of the Eustachian Tubes.

We have already alluded, page 90, to the Eustachian Tubes being liable to a variety of unhealthy phænomena. In these remarks we ventured to state, from the circumstance of their being the emunctories of the Tympani, and so intimately connected with the textures of the Fauces, that their disorders were probably more frequently of a sympathetic than of an idiopathic nature, and that each of these disorders would have the power of disturbing or destroying their functions. Indeed, we had only to investigate the apparent use of the different textures which enter into their composition, and then view them in connexion with the phænomena of existence, to be convinced of the justness of these conclusions; for we discovered that some of their textures had the power of dilating, others of contracting their calibre, whilst others were endowed with elasticity to enable the two to act and react on each other; that the membrane which lines the tubes was the continuation of the one which covers the fauces, and was continually secreting a fluid to protect their surface against the irritating properties of the liquid and aërial matter, which pass through them; and that the whole co-operated together to produce the intentions of nature. When we took a view of the œconomy of the Eustachian Tubes, again we perceived that every atom of matter which entered into their formation was continually in action, and undergoing changes during the whole period of life, whilst they were in the immediate vicinity of certain textures which were more subject to disordered actions than any other, and consequently very liable to sympathize with them. But although we stated that these textures were apparently more liable to disorders of a secondary than of a primary nature, we did not pretend to deny that they were also obnoxious to become the theatre of the latter. But this classification, though sufficiently intelligible in itself, does not appear to be of much practical importance; for if it be a law of nature for the body to become progressively

changed in its composition, for the purpose of sustaining subsequent actions; and if every action be, as already stated, the mere effect of a corresponding exciting or irritating cause, and that cause exists in the vital fluid,—it cannot be a matter of great consideration whether the disease assumes a primary or a secondary appearance. When a texture becomes the theatre of disease, its vessels must be affected before such an evolution can take place,—a predisposition, as it is called, to perform disordered functions must exist, otherwise such an effect could not appear; and when this is the case with the cartilaginous, membranous, muscular, or cellular textures of the Eustachian Tubes, they must soon exhibit the disposition, not only in the form of disease, but also in the phænomena subversive of the œconomy of the Ear,—they must give rise to aphonia, or dulness of hearing,—and, if not arrested in their progress, they must in a short time lay the foundation of permanent deafness.

Now if the remote cause of obstruction in these tubes depend on the existence of some morbid property in the blood, and the immediate cause in the predisposition of the vessels to take on faulty actions, it must be allowed that the actions themselves are of a very irritable or inflammatory nature, and that they, in general, first declare themselves in the vessels belonging to the textures of the fauces, or of their immediate neighbourhood. Indeed, among the various cases which have come under my care, I have frequently been able to detect either a hereditary tendency to disease in these parts, or evidence of secondary symptoms of siphilis. The membrane of the fauces and parts adjacent I have very uniformly found to have the inflammatory character. Sometimes, however, such obvious remote causes cannot be discovered, or even conceived to exist; for we occasionally find the most healthy subjects labouring under symptoms of obstruction of the Eustachian Tubes, brought on by a slight cold. But such instances cannot be a matter of surprise, when we consider that the mucous membrane is apparently more

susceptible of disordered actions than any other tissue, and that a very simple cause will frequently excite in it a very active state of inflammation*. How often do we hear of people becoming very hoarse, and subsequently deaf? and this even after every precaution has been taken against cold! In delicate constitutions, inflammations of the mucous membranes constitute by far the greatest number of diseases, and, where allowed to exist for any length of time, are frequently productive of consequences of a very serious nature.

The symptoms which attend obstructions of the Eustachian Tubes are frequently very different in different cases: but the following are, I am inclined to believe, very seldom absent; viz. difficulty in hearing, and that difficulty increased by the slightest inflammation in the membranous covering of the fauces; an occasional crack in the ear during the action of yawning, or swallowing the saliva; an inability to force air into the Tympanum of each ear, so as to cause a sensation of fulness or swelling, by closing the mouth and nose, and then blowing; and occasionally a deficiency in the secretion of cerumen or wax.

With respect to the treatment of obstructions of the Eustachian Tubes, various methods have been recommended: such as dilatation of the canals by mechanical means; or the formation of a new passage in lieu of the old one, by perforating either the Membrana Tympani with a stilette, or the Mastoid Process with a trepan; but neither of these modes of treatment has hitherto, in the hands of others, proved beneficial. In disease, the functions of the part affected, and the means which nature employs to sustain it, should never be neglected; otherwise, instead of relieving, we shall invariably augment the sufferings of the patient, and in the end, perhaps, bring his life into jeopardy.

* Some years ago I knew a gentleman who could not hear a saw sharpened without having inflammation of the membrane of the fauces. This, however, is a rare case: but nothing is more common than to hear of people being seized with hoarseness from the wind changing to the east.

Now the means which we have found best adapted for the alleviation or removal of the malady in question are very simple, and may with propriety be divided into two kinds, —medical, and surgical. In the former, we include all those agents which, when duly administered, seem to have the power of soliciting healthy secretions; for as long as the secretions continue in an irritable or unhealthy state, we cannot expect to succeed in removing or alleviating the effects of any disease. In no instance should the stomach and bowels be lost sight of; for it is from the regular formation of the chyle that the blood derives the greater portion of its properties, and these, like every other, are of a relative nature. When the alimentary canal has been cleared out by the usual remedies, a gentle excitement should afterwards be kept up by some mild aperient medicine, and its functions assisted by a proper regulation of diet. Nothing that can in any way irritate the fauces, or the stomach and bowels, should be allowed; and whatever can soothe the diseased textures should be administered,—such as the frequent inhalation of warm steam by the nose, the occasional application of leeches behind and under the angles of the lower jaw, and of blisters behind the ears or to the nape of the neck. When we have reason to think that the scrofulous diathesis exists, in addition to these remedies a few drops of the liquor potassæ or of the tinct. iodini in a little water should be given three or four times a day for several weeks; and when any taint of a siphilitic nature seems to be present, small doses of blue pill should be regularly persevered in for some time.

As to the surgical treatment, this consists in the occasional introduction of certain bodies of a conical form, such as the elastic gum or metallic bougie, through each Eustachian Tube to its termination in the Tympanum*. In applying these instruments, some difficulty will at first

* M. Guyôt was the first who proposed the passing of an instrument through the Eustachian Tubes; and Mr. Wathen appears to have been the first who tried it on the living subject with advantage.—*Vide* Phil. Trans. vol. xlix. p. 213.

be encountered: for until we acquire by experience the method of conveying the point of the instrument through the nose to the faucial extremity of the canals, the mere knowledge of their relative situation will not be sufficient to enable us to accomplish the purpose in view. The manner which I have found best adapted for this purpose is as follows: After selecting a bougie of the calibre and shape of the tube, and oiling its extremity, I ascertain by external measurement the distance from the orifice of the nose to the Cavitas Tympani, and then mark the instrument so as to know when I have succeeded in reaching the posterior extremity of the canal: I then bend the point a little, and pass it along the floor of the nose, with the point touching its outer and under surface, to the part at which the membrane of the nose is about to ascend to form the external wall of the cavity, until I have reached the fauces: I then gradually raise the point of the bougie, so as to touch the lateral surface of the faucial cavity as I push it backwards, turning it in its course first a little to one side and then to the other; and when I find that it becomes loosely fixed, and does not descend towards the pharynx, I conclude that it has entered the Eustachian Tube: I then continue pressing the bougie gently onwards until I perceive the mark which I had made has reached the orifice of the nose; and after allowing it to remain a few minutes, withdraw it in as gentle a manner as it was introduced. When, however, I find that the point of the instrument does not get into the faucial extremity of the Tube, I make it a rule to lay it aside for two or three weeks, and to employ a silver probe instead. But sometimes the passing of the latter instrument will be attended with as much difficulty as the former; and when this is the case, the same rule should be observed regarding its repetition: for the principles upon which these instruments should be employed are the same as those which ought to guide us in the treatment of susceptible surfaces generally. After subduing the action which has been excited in the diseased part by the means recommended, the instruments should

again, but not till then, be employed. The first application of the bougie will in general be accompanied with some pain; but as this sensation does not arise from the presence of any additional morbid cause, it will in a short time subside, and the patient will feel considerable relief. We must not, however, repeat the stimulus too frequently, for by passing these instruments too often, as much harm as good may be done. In treating obstructions of the Eustachian Tubes, we should be guided by the same principles which serve us in the cure of other diseases. When we repeat a stimulus too frequently, we bring on considerable irritation,—and we ought to recollect that irritation was the original cause of the disease. No instrument should be introduced for some weeks after the patient has applied for relief; for this will always be attempted too soon, unless we have succeeded in soothing the irritation by exciting secretion: even after we have begun the use of instruments, once or twice a week should be the extent of our visitations. By introducing the instruments oftener, "we have," to use the words of the late Mr. Abernethy, "not only to counteract the irritation which previously existed, but the irritation which we have ourselves produced*." And it is from a want of attention to this circumstance, that the operation which we have been discussing has so repeatedly proved unsuccessful.

With regard to the operation of injecting the Eustachian Tubes with tepid water, as proposed by the late Mr. Wathen†, or of perforating the Membrana Tympani or Mastoid Process, as proposed by others, for the purpose of making an artificial passage to the Cavitas Tympani in lieu of the natural one,—we have only to consider the nature of the machinery of that cavity, and the principles of its

* *Vide* Lancet, vol. v. p. 326.

† A solution of sal ammoniac has been mentioned by Arnemann to be capable of curing several cases of deafness arising from obstructions of the Eustachian Tubes, on being injected into the fauces. I have not myself had any experience of its effects so as to enable me to recommend its adoption.

construction, to be convinced of the inutility, often of the danger, of all these procedures. Indeed, we have no hesitation in stating that the operation of injecting the Cavitas Tympani by the Eustachian Tubes with a view to their dilatation, cannot be done without first perforating the Membrana Tympani, and then running the risk of separating parts of the Apparatus Tympani from each other, and thus laying the foundation of a greater degree of deafness than had previously existed*. And as to perforating the Membrana Tympani, we may observe that, although it has been strongly recommended† in cases of the kind we are now discussing, it has very justly fallen long ago into disrepute, and is now only performed after every other means has been tried in vain. In no case in which I have given it a trial could I perceive the least improvement; and I may also add,—since it is evidently at variance with the œconomy of nature,—in none does its performance appear to me justifiable, except when we have reason to believe that an accumulation of matter has taken place in the Cavitas Tympani which cannot escape by the natural passage. Let us only reflect for a moment on the condition of the cavity when this operation is performed: Do we not place the membrane in the same situation as it is when ruptured, or injured by violence or disease? And does not the hearing become in general so morbidly sensitive through the irritation of the sonorous pulses coming in immediate contact with the Apparatus of the Tympanum, that the least noise gives rise to a confusion of sounds, accompanied by pain‡? In every case of the kind which has come under

* In the Edinburgh Journal of Medical Science, vol. i. p. 353, we observe a report made by Majendie to the Academy of Sciences of Paris, at their meeting in July 1825, on the subject of a boy, named Honoré Trezel, deaf and dumb from birth, who in the tenth year of his age obtained his hearing and speech while under the care of Dr. Deleau, jun. This case was said to have been cured by the employment of the means we are now condemning.—Query: Is not Honoré Trezel at present as deaf and dumb as at first?

† Phil. Trans., vol. xc. pp. 151 & 435.

‡ *Vide* Edinburgh Medical Journal, vol. i. p. 382.

my notice, these phænomena were so easily excited by speaking in a loud or high tone, and so readily removed by merely conversing in a whisper, that I discovered the cause of the imperfection and distress without any further inquiry, and likewise the means of immediately preventing such unpleasant effects;—for the mere introduction of a little dry lint into the Meatus Externus proved on trial to be sufficient to prevent the sonorous waves from reaching the Cavitas Tympani with an irritating degree of force, and consequently from producing confusion and pain.

We are aware it may be said, that when we have punctured the Membrana Tympani experimentally, we might subsequently render the Eustachian Tube pervious by injecting it through the new aperture with warm water; or that even should we fail in this attempt, the adhesive inflammation which in general sets in would soon repair the injury done, and leave things in no worse a state than they were. To these remarks we may observe, that the injecting process would be attended with much difficulty and danger, and that in the absence of all experiments on the inferior animals, we could not be justified in hazarding a trial on the human subject. As to the adhesive inflammation which is to repair the injury done, this is beyond all doubt a most fortunate circumstance; for were it not for this provision of nature, we should have had many distressing instances of the ill effects of any endeavour to pervert her harmony. Under no circumstance does the operation of puncturing the Membrana Tympani appear admissible, except in the single instance we have noticed. It should, therefore, never be attempted without the utmost consideration*.

But if the operation of puncturing the Membrana Tympani be objectionable,—what are we to say in support of that of perforating the Mastoid Process? Can we, notwith-

* In the Universal Magazine for 1763, it appears that the Membrana Tympani of dogs had been punctured on various occasions, and that they soon afterwards became deaf.

standing all that has been said by Loeffler, Arnemann, and others, in recommendation of its adoption, be induced to entertain an idea of its propriety? When the Mastoid Cells are in a carious state, or appear to contain a fluid, it would of course be advisable to remove the carious parts or matter by an operation; for as long as that morbid bony or liquid material exists, the mischief to the organ would be progressively increasing. Under any other circumstance I cannot think that the Mastoid Cells should ever be disturbed.

It has been stated, that during the infantile period of life the osseous textures of the Ear are among the softest in the body, and that they appear from this circumstance to be very liable to disease, particularly in scrofulous subjects. A few weeks ago, my friend Mr. Linnecar brought me a piece of bone, including the entire Labyrinth, which had come away, by the Meatus Externus of the left Ear, from a patient of his, whom he invited me to visit in company with himself. On examining the bone, it appeared that the whole of the petrous portion had, like the shaft of a tibia when affected with necrosis, lost its vitality, and been detached by the ordinary process of nature. As the case was the first of the kind I had ever seen or heard-of, and one which would probably be the means of establishing some of the opinions I had long entertained, (and which have been noticed in this treatise,) I felt great anxiety to have the circumstances attending it investigated:—and in a short time I had the patient before me; a fine lively girl, about two years and a half old, but apparently predisposed to scrofula. On examining the child, nothing very particular could be discovered. Matter of a healthy appearance was exuding through the Meatus Externus of the left Ear; the face on the same side was a little swollen, and had lost its powers of motion, but not of sensation; for she could not bear the prick of a pin without crying. Her general health was apparently good. From Mr. L. I learnt that he had attended a sister of the patient for diseased

mesenteric glands, but that she had not exhibited any symptom of a scrofulous nature; that about twenty months ago (April 1830) he was desired to see the child, then about eight months old, and found her labouring under symptoms of phrenitis, which he treated in the usual way, and the patient soon recovered. In about a month or six weeks after this attack, a purulent discharge was observed to flow from the left ear (the child at the time being in apparent good health); but no notice was taken by the parents of this circumstance until after the expiration of three or four weeks, when the mother, on observing the face and neighbouring parts looking red, became alarmed, and sent for Mr. Linnecar again. On examining the ear he now found the discharge to be copious, of a purulent character, and excoriating the parts over which it passed: there was no complaint of pain, no heat or swelling about the ear; but the left side of the face, including the eye, seemed larger than the right, and the left eye was never closed during sleep. The patient seemed in good general health, for she ate, drank, and slept well, and was beginning to walk. Various remedies were applied; but the symptoms continued much the same, with the exception of the discharge, which had increased. At length the left side of the face became perfectly paralysed, and shortly afterwards the Ossicula Auditus were discharged through the Meatus Externus.—Mr. L. then lost sight of the child for three months, in consequence of her being removed into the country. On her return he found her labouring under irritative fever and disordered digestive organs, although the child in the interval had been apparently in good health. The discharge still continued from the ear, accompanied with a most offensive odour. A fungous excrescence was now observed filling the Meatus, whilst the Auricle was pushed out from the side of the head; and the child cried when the finger was applied to the posterior part of the organ, although there was no sign of inflammation. On applying the cupri sulphas to the fungus, it came away, but still continued growing rapidly, and required

the escharotic to be frequently repeated: each time it was removed he perceived a piece of bone gradually advancing from the bottom of the cavity. This at length came away spontaneously, and on examination proved to be the entire petrous portion of the temporal bone. Upon looking into the ear, Mr. L. could now see a considerable distance down the Meatus, which appeared at the bottom to be lined with healthy-looking pus. Since then there has been scarcely any discharge. The external Ear has been gradually returning to its natural size, and no one would now suppose so serious a disease had ever existed*.

It is unnecessary to offer any remark on the lucid and candid statement of Mr. Linnecar. It clearly proves that the osseous textures of the ear in scrofulous subjects are very liable to disease, and that the whole may be destroyed without affecting the general health.

* In the Medical and Physical Journal, vol. liv. p. 519, we observe a case recorded of a scrofulous child, four years old, being attacked with fever accompanied with pains in the neck, and who on recovering had a discharge of matter from the Ears, which brought away first the Malleus, then the Stapes, and then the Incus. And no loss of hearing is said to have taken place.

CHAPTER VI.

DISORDERS OF THE ORGAN OF SPEECH.

In discussing the functions of the Ear, we stated that those of the organ of Speech were subservient to them, and consequently that all its phænomena were of a passive nature. This passiveness or relative dependence shows that when the organ of Hearing is imperfect, or becomes the seat of disordered functions, the organ of Speech must sympathize with it, and prove imperfect in its actions also. Instead of being able to speak harmoniously, nothing but harsh and discordant sounds will be uttered: all the actions by which language is produced will be perverted to such an extent, as to render the evolution of articulate sounds impossible. As we hear, so do we endeavour to speak; and it is from the power of imitating sounds heard, that the whole of language is derived. To speak fluently, we must hear correctly; every motion which takes place in the Ear must be accurately and completely performed, and the Larynx must possess the power of proper imitation, otherwise instead of speech following with ease and correctness, the words will be pronounced in an imperfect manner, and the language will be nearly unintelligible. When this state of things exists, we can easily account for the mental principle which controls the functions of the larynx also getting into a faulty state, and for the different actions of this part becoming progressively worse; for if habit be, as we conceive, a kind of force or violence, done or superadded to first or primitive principles, it follows as a matter of course, that those parts which have acquired a power of

acting in a more forcible, or in a different manner* from that which primarily belonged to them, will become, from frequent repetition, a cause of action, the strength of which will coincide with the violence of the impression that gave rise to it; and consequently those which were voluntary will become involuntary, and *vice versâ*, and thus give birth to that confusion which constitutes stammering.

It is a common observation that habit, like every other principle of organic function, is always gaining on us, and that little force is necessary to keep it up. Thus persons accustomed to drink spirits gradually acquire the power of resisting their intoxicating properties; they consequently by degrees require a greater quantity to produce the desired effect, and at last become habitual drunkards. As in the body, so in the mind,—horrid sights, &c. first produce in it the greatest disgust and alarm; but by frequent repetition the mind becomes reconciled to them, and at last scarcely an idea is excited by their renewal. In accustoming or habituating parts, therefore, to impressions, two circumstances will arise. 1st, If the impressions are slight or often repeated, or if the force of the impression be at each time gradually augmented, the parts on which they act will become by degrees insensible to them; so that the cause will remain, though the effect diminishes or ceases. And 2ndly, The effect may remain though the cause ceases, as violent impressions will continue to produce their effects long after they themselves have been removed. According, then, to the kinds of habit complied with, health or disease will be induced. When the mind or percipient principle, therefore, becomes, from certain impressions given to the brain through the intervention of the ear, disposed or accustomed to evolve certain irregular actions in the loco-

* This is clearly illustrated among the lower orders of life. Bricklayers' labourers, without any spinal disease, soon acquire the habit of walking with one shoulder higher than the other. The same remarks are applicable to carpenters, and various other mechanics who make great use of their right arm.

motive machinery of the larynx, the disposition may with some propriety be compared to the state of an elastic body, when altered from its pristine to some other figure. The disposition of the elastic body to recover its original state is destroyed by its action in recovering that state. So when the disposition has produced such a state in the brain as to excite the moving powers of the organ of voice to any action, the disposition no longer remains: there is this difference, however, between the elastic body and the organ of voice,—that the former loses its disposition instantaneously, whilst the animal organ loses it by degrees. The first effect which the phænomena of sensation produce, is evidently the evolution of a certain motion in the muscles of the larynx. As soon as the child breathes, it begins to cry. It makes a noise which it never heard before; and this noise or action is the effect of a certain excitement which has been conveyed by the percipient principle of the brain to the moving organ. No irregular action is induced, for the child cries with the utmost ease and facility; but after the ear has become accustomed to evolve certain actions (*vide* pages 45 & 59), and to convey their effects to the brain, the primary disposition of that viscus becomes in like manner progressively changed. Whenever this state of things commences, a conflict between the primary and secondary actions immediately takes place, and the consequence is,—from the impossibility of anything continuing to exist in the same state for two successive moments, and from the continual transmutations which the vital power or theatre undergoes,—the gradual supercession of the first sentient principles by those of the second. The power of the sensorium to display the primary principles of volition in the larynx then no longer exists; and the consequence is, the establishment of a succession of actions in its locomotive machinery coinciding with the nature of the mental causes.

Now to apply these remarks to the imperfections or disorders of the organ of Speech. That the Larynx derives its principles of motion from the brain; that its muscles

act and re-act on each other according to the mode in which these principles are conveyed to them; and consequently that the functions of the one are to those of the other in the same relation as cause and effect,—these are data which I believe no one will be inclined to dispute. It must be evident, therefore, that whatever excites that part of the brain where the nerves of speech take their origin, or influences the secretions of these nerves themselves, will produce a corresponding effect on the functions of the larynx. When the cause of this excitement consists in any general or local property, it will depend, in the former case, on the state of the blood, and that of the secreting vessels of the nerves of speech; and in the latter, on the disposition of the organ of hearing,—and will, of course, be remedied by attending to the functions of that organ; for when the cause is local, we have only to investigate the nature of those actions which perverted the primary principles*, and subsequently pursue that mode of treatment which may appear best fitted for the restoration of these to their original state. Imperfections of speech arising from a local cause should be considered according to the same principles which guide us in the improvement of the muscular motions of the limbs in walking, dancing, &c. The habituating the ear to music, and insisting on the various evolutions of speech being performed in harmony with it, would, I have reason to believe, be productive of much benefit. When we reflect on the nature of those actions which the infant at birth employs in crying, and compare them with the tones of music, do we not perceive in both a regular succession of phænomena, all of which are the effect of perfect evolutions? And do we not gradually acquire the power of playing on a musical instrument? and also of singing (which is only an artificial species of natural language) by method and habitual exercise?

* I know a family in which the father and eldest child stammer considerably, whilst the second and third children do not stammer in the least, in consequence of having been removed when infants from the society of their parents until they were twelve years of age.

The more diligently we play or sing, the more perfect we become, and at length acquire that confidence and ease which are so conspicuous in the eminent professors of that branch of education. The art of improving the speech depends on the same principles: every action should succeed another in regular order; that which is the least complex should be acquired first, and thence the more difficult are to be gradually attempted, and fluency of speech will be the result.

When the disordered actions of the Larynx, however, depend on the existence of a general cause, the animal machine is invariably out of health; all the secretions from the blood downwards are in a faulty state; for in health there exists a perfect harmony between the fluids and solids, and consequently between the blood and its containing vessels*. In disease, in the same manner, every part sympathizes with another, and produces morbid effects corresponding with the nature of the morbid action which evolved them. When the blood is faulty, it cannot possess the power of sustaining healthy actions; and when the

* When we fracture the leg or wing of a hen during her period of fecundation or laying, the first egg which she subsequently lays will have its earthy shell much thinner than the former ones, and all that she lays afterwards will be without shells, having a membranous covering only, until the fracture has united, when they will again appear with their proper covering. Now, query—When a bone is fractured belonging to the human body, do all the others lose a portion of that matter which was previously intended for their support, until the fracture has united and become sound? In scrofulous subjects all the bones are easily fractured; and when a limb is found necessary to be removed, in consequence of a disunited fracture, or diseased joint of long standing affecting the general health, we occasionally find the patient will have a fracture of the stump, or some other bone, on using a little violent exercise. Some years ago, when attending St. George's Hospital, a scrofulous boy had his leg amputated for a diseased knee-joint of long standing; a few days after he began to use the crutches his foot slipped, and although he did not fall, the sudden action of the muscles of the stump fractured the bone a little above its extremity. Such phænomena, and those observable in the hen, incline us to think that all the osseous textures in the body suffer, and become less in substance during the existence of a fracture.

faults are more connected with the properties which nourish and vivify the nerves of speech than any other, imperfections in the evolutions of the muscles of the Larynx will be the necessary consequence, and these will progressively increase if not checked by the administration of proper remedies; for it is a law of nature, that every organic machine shall act according to the nature of its exciting causes; that the principles of its motions shall coincide with the properties of its materials; and that the chemical phænomena shall succeed the vital, and *è contrario*, to sustain the general œconomy. Now in the cases to which our attention is at present directed, I am inclined to think that the principal original cause of the imperfections arises generally from indigestion; that matter, containing few or none of the properties of life, has been transmitted to the stomach and bowels, whence it has, after producing a certain degree of irritation, been in part conveyed by the lacteals to the blood, and by the arteries to all parts of the body, and consequently given rise to general disorder; for among those cases which have come under my care, I have observed that particular constitutions were not alone affected, but that every kind was liable to such derangement, and that the symptoms invariably coincided with the quality and quantity of the pernicious materials concerned in their production. In proof of this I need only adduce the three following cases.

Case 1. A young woman, aged 22, of a good constitution, became gradually out of health, which she could not account for, except from having eaten about a month before something which produced much pain in the abdomen. In a short time she felt that she had some difficulty in articulating her words after sunset until the following morning, when on awaking she found the symptom had left her. This difficulty progressively increased both in severity and duration, until at last she could not articulate a single word from six o'clock in the evening until the same hour in the following morning of each day; at the same time she became so unwell as to be unable to attend her daily avo-

cations. In this state she applied to me. On inquiry I found that her general health was very much out of order. She had no appetite; and whatever she ate brought on, in a short time, a slight degree of sickness. Her bowels were very much confined; urine of a porter-colour, and depositing a sediment somewhat like brickdust. Catamenia seldom seen, and, when present, very scanty: feet swelling after a little exercise; and face exhibiting the chlorotic hue, with a sleepy eye.

Considering the case to have arisen from the introduction of some pernicious property into the blood, and the great variety of symptoms to depend on the existence of faulty secretions, I ordered her an emetic, and subsequently a few grains of the extr. aloes spicat. in solution, to be taken three times a day, and to apply a perpetual blister to the nape of the neck. In three days all the symptoms were alleviated, and in the course of three months she quite recovered.

Case 2. A young man, aged 19, of a delicate constitution, felt a little unwell after having eaten a few oysters, and in a short time became so ill as to be unable to keep his situation. At last he was seized with fever, and shortly afterwards exhibited symptoms of paralysis of the muscles of the tongue and larynx. From being in poor circumstances he applied to a dispensary for relief. In the course of a month the fever had entirely subsided, but the difficulty of speaking continued as bad as ever. Every means which his medical attendants thought advisable to administer were tried, but to no purpose, and the symptoms got progressively worse. Six months afterwards he came under my care.

Considering the case to have arisen from a similar cause to the former, and to be kept up by faulty secretions,—for he was evidently very much out of health,—I ordered him to take an emetic every morning before breakfast, and a pill composed of seven grains of the extr. colocynth. comp. and three grains of calomel every night for a week. At the expiration of this time he was considerably better, and could

then articulate his words almost as well as he ever did in his life. Ordered the remedies to be repeated every alternate morning and evening for a fortnight. At the expiration of this period he felt completely recovered; nor has he had any return of the complaint, although it is now six months since he ceased his attendance on me.

Case 3. A strong muscular man, aged 30, by trade an engineer, went to France, about two years ago, to erect a steam-engine. Shortly after his arrival he found that the French cooking did not agree with his stomach, and in a short time he became very much out of health. Within two months he was confined to his bed with fever, accompanied with furious delirium. On recovering, he found that he had lost his memory and speech, and that his constitution had become so enfeebled as to make him unable to attend to his work. In this state he returned to London, after an absence of eighteen months. Shortly after his arrival he went to an hospital; and after being under various modes of treatment for four months, was discharged at the request of himself and friends, without having derived any benefit. He then applied to me.

On examining him, I perceived that his face had a dingy yellow colour; his eyes were exceedingly dull and vacant, and his hearing, smelling, and tasting, very much impaired: he could not lift his arm or his foot without evincing great muscular and nervous debility, and he could scarcely articulate his words so as to be understood. His memory had almost entirely left him:—indeed he seemed to be altogether out of health, and in a very precarious state.

Considering the mischief to have arisen from faulty secretions, and to be sustained by the existence of certain properties which had got into the blood through the medium of the digestive organs, I directed him to take an emetic every morning before breakfast, and a pill composed of the extr. colocynth. comp. grs. vij. and hydr. submur. grs. iij. every night at bed-time for a week; to abstain from all kinds of liquors, wines, &c. and to live on that kind of food which he found he could easily digest. Six days afterwards

I saw him again, and found him considerably better in every respect. All his sentient faculties, together with his memory and speech, were much improved, and he could now lift his arm and walk as steadily as he ever did in his life. I ordered all the remedies to be continued for another week, and after that period to be repeated every alternate night and morning for ten days longer. At the expiration of this time he again called on me, and told me that he had walked all the way from his house to mine (a distance of five miles,) without feeling the least fatigue, and that he was now quite recovered, and intended to return to his work in the course of a week or two.

Perhaps some will consider the mode of treatment pursued in these three cases to be very strange, and in some degree to militate against the sentiments which I have ventured to express on the treatment of disease in another part of this work. A little reflection, however, will convince them that it is perfectly consistent with the laws of the animal œconomy, and that instead of being against, its success in a great measure substantiates the doctrines which I have delivered on the subject. The human body, as a whole, can only be viewed as an organic machine, and performing evolutions according to the design and intentions of its Author. When its actions are of a violent nature, they can only be arrested by means of a similar kind. The morbid or superfluous power, which may be disturbing the harmony of the various actions, must be removed either by an artificial emunctory, or by those which have been formed for that specific purpose,—and that too before it has perverted the animal œconomy, and produced organic disease. And what agents do we possess that can excite so speedily such copious secretions as emetics? Do they not cause the secreting vessels of the stomach,—in all probability, if not the sole cause of the disordered actions, at least very much concerned in their continuance,—to pour out large quantities of fluid matter, and also those of the skin to throw

off perspirable matter in great abundance? Do they not remove every action of a spasmodic nature, and subsequently cause the different fluids necessary for nutrition, as well as those of an excrementitious nature, to be poured out from their respective vessels, and thus considerably improve the properties of the blood? But the result of the treatment is at all times the best criterion of its propriety: All the patients were soon restored to health, and that too without experiencing much inconvenience from the operation of the remedies;—the emetics never excited violent vomiting, nor the aperients much purging.

Since these cases have occurred, I have tried the same mode of treatment in epilepsy, hysteria, tic doloureux, and several other nervous affections; and in all, the result has been of the same flattering description. But to return:

These cases clearly prove that disordered functions of the vocal organs owe their origin to general as well as local causes; that the former are frequently produced by indigestion, and are capable of being removed by exciting the various secretions by certain medicinal remedies; and that the latter, from what we have already stated, are the effects of certain impressions produced by the actions of the organ of hearing on the sensorium, and are susceptible of being relieved by attending to those principles which constitute habit. There are other causes, however, which have the power of depriving the organs of speech of their due actions, and which cannot be ascribed to the existence of any general property, or to the functions of the ear, namely, inflammation of the mucous membrane, and muscular textures of the larynx. How often do we find people complaining of a hoarseness, which in a short time ends in depriving them of the function of speech?* When these

* In the Phil. Trans. vol. xlv. p. 148, we find the case of a Mr. Oxford recorded, who in the 28th year of his age lost his speech from a cold, and remained dumb for four years, although every means which his medical advisers could think of had been tried, when he one evening went to bed in a state of intoxication, and had a frightful dream which awoke him, and to his astonishment he found his speech restored.

textures become the seat of inflammation, the morbific or morbid action must necessarily deprive them of that degree of elasticity which is requisite to the evolution of their functions; and when allowed to continue for any length of time, must soon cause such a thickening or increase of the structures, as to render them unable to obey the influence of the will, and permanent inability to utter a word, as a matter of course, will supervene. In the treatment of these cases the antiphlogistic plan ought to be strictly adhered to; and when that fails, every means which may appear to have the power of exciting the absorbent vessels to remove the morbid matter should be administered. A certain kind of action should be constantly kept up for some time; and as long as that action improves the general health, we should not cease in sustaining it. We cannot expect to alleviate or remove a chronic disease by the employment of any remedy for a short period; neither can we, in these cases, render any relief but through the medium of healthy secretions, and these can only be procured by the constant administration of gentle remedies.

THE END.

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