ANATOMICAL INVESTIGATIONS,

COMPRISING

DESCRIPTIONS OF VARIOUS FASCIÆ

OF THE

HUMAN BODY;

The Discoveries of the Manner in which the Pericardium is formed from the Superficial Fascia; the Capsular Ligament of the Shoulder Joint from the Brachial Fascia; and the Capsular Ligament of the Hip Joint from the Fascia Lata.

TO WHICH IS ADDED

AN ACCOUNT OF SOME IRREGULARITIES OF STRUCTURE

AND

MORBID ANATOMY;

WITH A DESCRIPTION OF A NEW

ANATOMICAL TABLE.

BY JOHN D. GODMAN, M. D.

LECTURER ON ANATOMY AND PHYSIOLOGY;

EDITOR OF THE JOURNAL OF FOREIGN MEDICINE; PROFESSOR OF PHYSIOLOGY TO THE PHILADELPHIA MUSEUM; MEMBER OF THE ACADEMY OF NATURAL SCIENCES: HONORARY MEMBER OF THE MEDICAL SOCIETIES OF PHILADELPHIA, MARYLAND, BALTIMORE, LEXINGTON, CINCINNATI, PITTSBURG, &c.

PHILADELPHIA:
H. C. CAREY & I. LEA.—CHESNUT STREET.

1824.

TO

STUDENTS OF MEDICINE

IN PARTICULAR,

AND LOVERS OF IMPROVEMENT GENERALLY,

THESE FIRST FRUITS OF THE

ANALYTIC METHOD

OF STUDYING AND TEACHING

ANATOMY

ARE MOST RESPECTFULLY

DEDICATED

BY

THE AUTHOR.

INTRODUCTION.

THE following investigations were begun without reference to any system, and without the slightest wish to support any preconceived opinions. The conclusions drawn were unavoidable, even at first inspection, and their correctness was more firmly established by every subsequent examination. The researches were originally made, in every instance, in the presence of a class of students, most of whom had attended two courses of anatomical lectures, and were considerably experienced in dissecting. They were stationed as near as possible to the table and requested to suffer nothing to pass them as ascertained, of which they were not entirely satisfied by the demonstration. They saw every touch made with the knife, and were thoroughly able to judge of the difference between what really existed, and what might have been accidentally produced. The results of all the investigations made in the presence of the class, and before the members of the profession especially invited to witness them, exactly corresponded with the descriptions here given. There was no ambiguity either in the continuation, extent, or density of the Fasciæ and processes.

It is much easier to *demonstrate* the whole of these structures, than to convey an accurate idea of them by description, as to the repetition of technicals, and the reader's want of *precise* recollections of the parts referred to, necessarily give an appearance of obscurity to a minute anatomical detail.

The mode of teaching anatomy by a pure *Analysis*, which it has been my happiness first to introduce and establish by the fairest experiment, is the only method which can free us from the trammels of long reigning prejudice, or the dominion of ancient errours, that have become prescriptively established by frequent repetition in "systematic works." By this method the *teacher* is always placed in the condition of a *learner*, and no authority is accredited but *demonstration*—no book is valued until its descriptions have been tested by a rigid scrutiny, in direct comparison with the structure as fairly exposed, and competently observed. This appeal from *books* and *authorities* to *nature*, disperses the clouds which have too long involved the science of Anatomy—removes the difficulties that have impeded the advances of the inquiring student, and opens the way to improvement, discovery, and truth. In order to satisfy such as may not have read the exposition of this method, which was published a few months since, the following extract may be advantageously presented.

"In consequence of a careful investigation of the modes of teaching anatomy, I have been induced to resort solely to the method of *Analysis* or decomposition. The subject is placed before the learner *untouched;* the knife is not used to clear obstructions from the way of the teacher, *previous* to the lecture. The STUDENT *sees* the relation of parts—the *Anatomy,* as it is left by the hand of nature: he observes the manner in which they are to be successively removed—he sees the situation and company with which they are always to be found, and perceives that in this mode of examination there are no difficulties to impede his progress, but inattention or neglect. The body is *decomposed* by the knife in his sight, and he soon acquires a clearness of information on the connexion of parts existing in the living system, which enables him at any moment to recollect what is to be encountered in any portion of the frame. The physiology he learns does not consist of a collection of scraps and fragments relative to each part separated, but it is the *whole* that can be learned, from *the whole* in combination. Should the teacher even be inadequate to the task of *telling* him *all* that is necessary, yet as the student *sees* the veritable anatomy for himself, his subsequent reading is always aided by recollecting the *actual condition* of the structure."

"In fact we believe no cause has acted more powerfully in retarding the advancement of the science of medicine, than the injudicious mode of teaching anatomy *synthetically*. In this way, we can easily account for the limited and unphilosophical views of physiology and pathology which have been given to the world. One teacher acquires a habit of paying an exclusive attention to the nerves, and all his views are *nervous*—another scrutinizes the arteries, and all the theories he forms are *inflammatory;* a third studies the veins, and *congestions* and *engorgements* are the night-mares that oppress him; a fourth pores over the absorbents, and he is in continual dread, lest the balance of the system should be destroyed; a fifth looks entirely to the muscles and his mind can perceive nothing but alternations, of laxity and tension, of tonic and clonic contractions, of debility and spasm!"

——"In teaching anatomy by the analytic method, the teacher has not so good an opportunity of making the parts *look beautiful* as in the ordinary modes of instruction. He must of necessity show the structure exactly as it is; and must be content with the advantages his class receives from correctly understanding the subject. While learning the relation of parts, the class is in general too usefully and agreeably employed, to think of the *sights* they might have, were the lecturer at liberty to prepare them before hand, at the trifling expense of destroying a few fasciæ arteries, veins, nerves, tendons or muscles! It is true, that in this mode of teaching, the lecturer will find it no easy task to commit a lesson *to memory*, and he may occasionally err in his descriptions; yet as he opens the faultless volume of nature *before the eyes* of his class, an error in *his* speech does not place a veil over their sight; nor does an inaccuracy in his detail, produce any inaccuracy in their perceptions."*

The discoveries now announced are the immediate fruits of the adoption of this method of teaching, and their importance may be gathered from a consideration of the following particulars. The fasciæ of the human body have heretofore been considered very numerous, and in a great degree independent of each other. One fascia has frequently been described under many different names. By these researches all the fasciæ have been reduced to *three*, *all* of which are fairly continuous at certain points. We show that all the fasciæ heretofore described, (with the exception of the temporal, palmar and plantar aponeuroses) are offsets or processes from these three fasciæ. The first and most striking advantage is the simplification of what has till now been unnecessarily esteemed complex. By explaining the connexion of the processes with the parent

* See the Introductory Lecture on "Analytic Anatomy," published by the class, Feb. 1824.

fasciæ, and pointing out their relations with the different structures, we are enabled to form a clearer idea of the natural and morbid condition of the parts; this is an advantage only to be appreciated by those who know how miserably inaccurate the ordinary conclusions relative to functions are, when drawn from the knowledge of the structure, obtained in the usual *synthetic* manner.

The discovery of the formation of the PERICARDIUM from the fascia superficialis removes a great stumbling block from the path of the student, who is inevitably bewildered when he tries to comprehend how a delicate SEROUS membrane, the *pleura*, can form a strong FIBROUS capsule such as the *Pericardium*, as is usually taught.

By demonstrating that the sheaths of the vessels are formed not from mere *cellular substance* but by processes of a dense fibrous membrane, which offer an equal resistance to the dilatation of the blood-vessels, a great difficulty is removed, which has long existed relative to the physiology of the circulation; so much has been said about the *elasticity* of the vessels that many have been induced to believe them entirely free from the ordinary laws of hydrostatics. The formation of the sheath shows us, that they must be when distended, nearly in the condition of rigid tubes; this enables us to perceive satisfactorily how an impulse given by the heart can effect with the slightest loss of power, the whole column of blood from the centre to the circumference of the system, and does away the necessity of looking for other causes than the heart to propel the circulating fluids.

Among the most interesting parts of these researches, is the demonstration of the manner in which the capsular ligaments of the great joints are formed. I am by no means anxious to claim great merit for *proving* the continuity of fasciæ, and the connexions thus produced between different parts—although BICHAT contented himself with *asserting* that the fibrous membrane may be traced into the *periosteum.* But I do expect the thanks of anatomists and physiologists for having pointed out the mode in which the capsular ligaments are made up from the coverings of the muscles, and thus rendering their natural conditions more intelligible and opening the way to new views of their possible situations resulting from disease or accident. I am sure of receiving the grateful applause of every unprejudiced student for having in this part of the science substituted simplicity for complexity and regularity for confusion.

Nor is it pretended that this subject is exhausted; other investigators may make such discoveries as will entitle them to correct and modify some of the details herein advanced. But we have repeated the examinations too frequently, and in the presence of too many critical judges, to have any fear for the general principles proposed. With a full assurance that a repetition of these dissections will convince even the most prejudiced, they are offered to the professional world, and we await with pleasure, the decisions of such as examine for themselves. Those who do *not examine*, have *no right to offer* any decision, whatever notions they may entertain. In matters of *probability* men may judge from a statement of the reasons for and against a conclusion; but when facts are announced, whose existence can be established or denied by *demonstration* and *experiment* alone, he who neither experiments nor demonstrates must be silent, or speak in vain. We ask no man "to vouch for" the truth of what is here advanced—we wish *all* to examine, and their testimony will be favourable.

The novelty of these descriptions will, perhaps, be the greatest impediments to their general acceptation, for it has been very correctly remarked by an illustrious anatomist,* that there are many per-

"* Que de personnes s'effarouchent de la seule announce d'idées nouvelles? Si j'ai la conviction qu'on m'ait attaqué sans m'avoir compris, je me dispenserai de répondre. Car, a quoi bon se tourmenter pour prouver, qu'on a eu raison? Le temps met chaque chose à sa place."

Geoffroy Saint Hilaire.

sons who become furious at the mere annunciation of new ideas:—like him, however we shall wait patiently, convinced that time fixes every thing in in its place.

ANATOMICAL INVESTIGATIONS.

SECTION I.

The Fascia Superficialis.

Various parts of the human body are so imperfectly and obscurely described, as often to excite a doubt of their true nature. This evil is of great magnitude, and results from various causes, none of which are so active as a habit, becoming too general, of considering the structure of individual textures insulated from all others and independent of their relations—as concerned in a single disease or connected with a particular operation in surgery.

Hence small portions of the same membrane are known by different names, and very minute descriptions are given of each separately, so as to convey to the mind an idea of several distinct membranes, where there is in reality but one. Even if this conclusion be not drawn by the uninstructed, it is very certain, that every person, from mere reading, infers that these membranes, fasciæ, &c. are extremely difficult to be understood, and that a thorough knowledge of them can scarcely be acquired. Some pupils are so strongly impressed with this idea, that they avoid the examination of such parts, and pass them by, as things on which much time may be spent, without the attainment of any equivalent good.

The fibrous membrane which covers the whole of the trunk, and a very considerable part of the extremities of the body, is one of the really important and perfectly simple structures, which has been made difficult, solely by considering it in fragments, and describing those with most tedious minuteness—though without any compensating clearness of arrangement, or accuracy of detail. With a hope of exhibiting this part of anatomy more advantageously to the student, and of removing some of the obstacles before mentioned, these investigations are begun—and should the effort be followed by any success, the author will be encouraged to extend his attention to other parts of equal importance, which hitherto have been offered to the learner under a similar veil.

By making a crucial incision through the integuments of the abdomen, from the ensiform cartilage to the pubis, and from the crest of one ileum to the other, going no deeper than the loose cellular substance, we may reflect the integuments on all sides, so as to leave the *fascia superficialis* untouched.

If we then lightly make another crucial incision, we divide the *fascia superficialis*, and encounter a layer of cellular substance, more delicate than that which lies between the integument and fascia, yet in general very distinctly perceptible. By dissecting cautiously, the fascia may be reflected in every direction, though it can be done with more ease where it lies over the tendon, than where it covers the muscular fibre.

Let us first examine the inferior part, which we shall find descending towards the top of the thigh, slightly connected by the intervening cellular texture to the tendons of the abdominal muscles, until it reaches Poupart's ligament, to the external or iliac portion of which it is more closely attached. As we approach the os pubis, near which it covers the spermatic ring and cord, the handle of the knife may be used to separate it from the tendons—and by looking under the fascia, when thus raised, without reflecting it, we obtain the fairest view of the real character and situation of the spermatic cord. The fascia receives a very considerable thickening near the pubes from the lamina of cellular substance exterior to it—and it is continued over the corpora cavernosa penis, as well as sends down a strong sheet into the scrotum, which has received the name of Camper's ligament. This portion descends obliquely in the direction of the cord, which it covers, and of the testicle, which it surrounds. The external portion passes downwards, over the whole of Poupart's ligament, to the upper part of the thigh, lying immediately under the integuments, and over the cluster of lymphatic glands and vessels, which fill up the depression below Poupart's ligament. As it approaches the top of the thigh, it gradually becomes thinner, and loses its regularity of texture, verging to the appearance of common cellular tissue: it may still be traced some distance down the inner part of the thigh, until it is lost in common cellular texture, lying in contact with the fascia lata and integuments. We may next raise the fascia superficialis from over the crest of the ilium, and pursue it backwards to the spine, and we may follow it downwards covering the whole of the *gluteal* muscles, where it is strengthened by large additions of cellular texture. As we approach the tubera ischii, the fascia becomes more closely attached to the surface, and in many instances seems to terminate there. This, however, is not the case, as it may be followed across covering the whole of the perineum, forming the strong fascia, which presents to the knife immediately after the first incision in lithotomy. We trace it from the perineum upward, until we lose it on the under surface of the penis, where it mingles with the covering which this organ derives from the anterior part of the fascia.

Returning to the central part of the abdomen, we prosecute our dissection upwards. We raise the fascia superficialis from the tendinous sheath of the rectus with facility, but find it so closely adherent to the proper coat of the muscular fibre, as to require some care for its separation. This, however, may be effected with comparative ease, and we lift it from over the lower part of the sternum and pectoral muscle, and from the superior part of the external oblique. We trace the fascia with great facility towards the spine, and find it giving a strong covering to the muscles of the back.

When we raise the anterior part to within a hand's breadth of the clavicle, we see the *platysma myoides* is on the outside of the fascia, and in immediate contact with the integuments, stretching obliquely upwards to the angle of the jaw, its anterior fibres ascending to the angle of the mouth, and the posterior in many instances rising to the zygoma, and connecting itself with the outer part of the orbicularis oculi.*

Having removed the *platysma* carefully, we then

* As this first section was sometime ago published, I have thought it best not to change it materially in this work. The truth of this description will not be affected by the slight modifications made after other more careful researches.

obtain a view of the superficial facia covering the whole of the neck, ascending in front to the edge of the chin, where it is lost in cellular and muscular substance. As we pass towards the angle of the jaw, we find it rising higher, (though thin,) covering the masseter muscle, attaching itself to the zygoma with firmness, and extending towards the ear, so as entirely to overlay the parotid gland, and prevent us from obtaining any distinct idea of its precise figure. From the back and upper part of the zygoma we see it passing up on the outside of the temporal fascia, and including in its substance the *anterior auris* and *attollens aurem.* The portion covering the shoulders and back of the neck continues over the occipital belly of the occipito-frontalis, and may be traced over this muscle, and continuous with the lateral portion until the muscle becomes united with the scalp.

After gaining this view of the exterior of the superficial fascia, let us return to the anterior part, and make a careful incision from the centre of the sternum to the centre of the chin. Then we reflect the superficial fascia towards the shoulder, and thus uncover the sub-maxillary glands and bellies of the digastric muscles above, and the sterno-cleido-mastoideus, throughout. Tracing the fascia to the posterior edge of this muscle, we shall find it to split, or form two portions, the anterior of which (the part reflected) doubles immediately around the sterno-cleido-mastoideus, and goes forward again towards the trachea, and anterior part of the neck, covering the muscles of the os hyoides, &c., the trachea, and thyroid gland. Below it may be traced the edge of the clavicle, and above the os hyoides and thyroid cartilage. The other part runs outwards and backwards from the posterior edge of the mastoideus—extending downwards, attaching itself to the acromion and spine of the scapula, where it gradually blends with the general superficial fascia on the back. Thus the sterno-cleido-mastoideus is enclosed in a distinct sheath, the same fascia forming both the deep and superficial covering of the neck. This part of anatomy, although it may have been *known*, has never been described with precision, and I may claim the merit of a discovery with much less danger of losing my title than has occurred in the case of others. Even Colles, with all his minuteness, has not attended to this really beautiful arrangement, which enables us to understand the anatomy and pathology of this region with much more clearness, than if we considered these to be distinct structures.

The last part of the fascia superficialis to be traced is that which we find extending from the pectoral muscle and clavicle over the deltoid, and surrounding the muscles of the arm, continuing over the elbow, exterior to the fascia of the biceps muscle, down to the back of the fingers.

After the general examination of the extent and relations of the fascia superficialis, we may with great profit attend to the different modes in which it may affect the conclusions of the physician or the operations of surgery. In doing this, for the sake of regularity, we may begin with the superior portion. Here we may observe that the manner in which it is attached to the zygoma and covers the parotid gland will prevent us from readily discovering a fluctuation. The peculiar arrangement of the fascia, which encloses the mastoideus, enables us to understand why a suppuration of this gland always breaks anterior to the muscle, and why the matter does not find its way among the deeper seated parts of the neck. If we consider that the portio dura, or respiratory nerve of the face, comes out through the parotid after having passed through the foramen auditorium internum, we shall not be surprised at the extreme pain in the ear produced by an inflammation of the gland which must violently compress this nerve through the agency of the fascia superficialis and the surrounding bony structure. The anterior portion covering the submaxillary gland will exert a pressure of the same kind. though by no means so great, as the surrounding parts are very different in character. Over the pectoral and other muscles, this fascia will necessarily exert a similar influence when tumours form or suppurations ensue. By attending to the differences in the strength and degree of attachment of this fascia in various situations, we may form a tolerably correct idea of the course that matter would follow. Certain diseases convince us clearly of this, as may be learned from the following dissection made during the last winter. A patient died of infiltration of urine, succeeding to a rupture of the urethra *in perineo.* The urine had gradually made its way upward, and had passed into the scrotum, which was in a state nearly approaching to putrefaction. The urine had followed the course of the cord, and had separated the fascia superficialis from the tendon of the external oblique, considerably above the crest of the ilium. Here the attachment was too close to permit its passage farther. Below it was bounded by the attachments to the tubera ischii, and on the upper and inner part of the thigh by the attachment to the fascia lata.

It is almost unnecessary for me to dwell on the importance of the anterior portion of the fascia to the surgeon. In hernia it is frequently very much thickened, and its appearance entirely altered by inflammation. In scirrhus of the testicle it may also be changed in character, and by this change add materially to the unfavourableness of our prognosis. Whenever we are to operate in this region, we should recollect that the fascia superficialis comes into view as soon as we have divided the integuments and a portion of cellular substance.

That part of the fascia superficialis which covers the *gluteal* muscles is also well worthy of consideration. Sometimes the matter of lumbar abscess makes its way out of the ischiatic notch, following the cellular substance surrounding the vessels. In one case, which fell within my own observation, the appearances presented by a collection of matter were such as to deceive several skilful surgeons as to the real nature of the case. It appeared to be a circumscribed, or an encysted tumour. There was nothing in the history of the case to induce a suspicion of its real nature, so that it was resolved to remove it with the knife. A crucial incision was made and the flaps dissected back, so as to discover the surface of a large sac, occupying nearly the whole extent of the buttock. When the operator began to cut round the base of the tumour, the nature of the disease was at once seen. An opening, made by the knife, let out a vast quantity of flaky matter peculiar to scrofulous abscesses, and the patient, in a few weeks, exhibited signs of hectic, soon succeeded by colliquative diarrhœa and death.

This case will point out the propriety and importance of making a small puncture with a needle or a lancet in every tumour of doubtful character, as advised by Pott in the case of diseased testicle, and by Abernethy as a general rule. Had it not been for this posterior portion of the superficial fascia, the matter of this abscess would have found its way down to the extremity of the limb, as it would have been entirely external to the *fascia lata.* It is solely by the acquisition of a thorough knowledge of the relations of parts, that a surgeon or physician can properly decide on the true character of diseases.

The fascia superficialis is neither very vascular nor sensible. Its arteries are derived anteriorly from the extreme branches of the intercostal, mammary and epigastric arteries—posteriorly, from the branches which nourish the muscles of the back. There are in front two veins descending from the navel to the top of the thigh, running over Poupart's ligament, which are the only vessels worthy of notice, though they are not very important. They help to return the blood sent out by the superficial arteries, and empty into the great vein below the ligament. The nerves of this fascia are very few, although it is perforated in many places by the extreme branches of the intercostal nerve. It cannot be supposed that a fascia of this kind is possessed of any remarkable degree of sensibility, or that it is supplied with a greater number of nerves than is required to maintain it in proper relation with the rest of the system.

I am well aware that in many cases the fascia superficialis does not, at first view, appear continuous to the entire extent herein described. That in certain situations it is more closely attached to the subjacent parts than in others, is also well known —yet as we frequently find subjects in which the closest of these attachments offer no obstruction to the raising of the fascia as above pointed out, we see no reason why it should not be described as a general fascia, which it really is, instead of a number of disconnected fragments, scarcely reducible to order, and almost unintelligible. By the former method we avoid confusion, and assist the learner to form correct opinions of its general character and uses: by the latter, a needless perplexity is occasioned, and the advances of the student are injuriously retarded.

SECTION II.

Fasciæ of the Neck.

One of the most interesting arrangements observed, is that of the *facia superficialis*, on the front and lateral parts of the neck. The first section contains a description of the manner in which the sterno-cleidomastoideus is included by the external and internal layer of the superficial fascia, which last has heretofore been considered to be the deep seated fascia of the neck. By my more recent examinations, the correctness of what was advanced relative to the sheath of the mastoideus was throughout confirmed—But I have been led to remark that the arrangement of the fascia below this muscle is very different from what is usually represented, and that its true character has not hitherto been made known.

In order to make the description as clear as possible, it will be necessary to repeat a small part of what was before stated concerning the fascia, as it passes from over the thorax to ascend on the neck, and also slightly to modify the description.

If we begin about midway between the clavicle and fifth rib, to raise the fascia superficialis towards the clavicle, we shall find when we arrive at the origin of the platysma myoides, that a layer of the fascia, which is thin and delicate, goes over the surface of this muscle, while a stronger and denser layer, continuous with the part raised from the thorax, runs underneath the platysma, and extends upwards to the zygoma. By this the masseter muscle and parotid gland are covered, and their figures concealed. Should we now commence in the centre and dissect the platysma myoides carefully off, we have a fair view of the external layer of the fascia superficialis, leaving out of the account the slight covering of the platysma myoides.

Next make an incision over the centre of the trachea, extending from the base of the os hyoides to the top of the sternum through this external layer. It may then be raised easily, towards the outside of the neck, until we have fairly laid bare the whole of the sterno-cleidomastoideus. If we cut off the origins of this muscle, and raise it carefully from its bed towards its insertion, without cutting the fibre of the muscle or the subjacent fascia, we shall see that the portion of fascia traced from the front of the neck over the last named muscle, splits just at the outer edge of the mastoideus, sending one layer outwards and backwards, (over the muscles of the neck and head) while the other runs inwards and forwards towards the centre of the trachea, and thus forms the lower part of the sheath for the mastoideus. This layer, immediately under the mastoideus, covers the internal jugular vein, the omo-hyoideus, and near the centre of the neck lies over the sterno-hyoideus. Thus far my researches were extended in the former essay, but it will be seen that the subsequent inquiries have led to a more extensive acquaintance with the true character of the fascia of the neck, and enable us to understand the manner in which the sheath for the great vessels is formed. To be convinced of the fact that *all* the fasciæ of the neck are processes of the *fascia superficialis*—to be assured that there are *six* distinct layers, or processes of this fascia on the front of the neck, and that the sheath for the vessels is formed by horizontal slips stretching from the anterior to the posterior portion, above, below, and between the jugular vein, carotid artery and eighth pair of nerves, it will be sufficient to pursue the following order of examination.

Suppose the superficial layer, or portion covering the mastoid, to be turned back as far as the outer edge of this muscle, and the muscle raised so as to exhibit the continuity of the outer and second layer. Then make an incision over the sterno-hyoideus (through the second layer,) from its origin to its insertion, and raising this layer towards the outer part of the neck, we shall find it forming a beautiful sheath for the omo-hyoideus, precisely analogous to that made by the superficial portion for the mastoideus, but being oblique to suit it to the position of the omo-hyoideus. Tracing this layer to the outer edge of this muscle, we raise the muscle from its bed, without injuring the subjacent fascia, and then we have this under portion, lying over the thyroid gland, and immediately covering the sterno-thyroideus muscle.

Let an incision next be made through this third layer, over the sterno-thyroideus in its length, and we raise the fascia as far toward the outside of the neck as to the carotid artery, and then we shall see how beautifully the process for the omo-hyoideus sets off from this third layer, which is on a level with the jugular vein, and continuous with the sheath of the mastoid muscle.

There is yet another distinct process going off from the fascia, where it touches the lower edge of the carotid artery. This fourth process runs forwards and inwards, covers the thyroid gland, and stretches across the front of the trachea under the sterno-thyroideus. If this layer be turned back towards the carotid artery, and the vein and artery be raised by pulling the superficial fascia upwards, we see a perpendicular process of the fascia, reaching from the under surface of the vessels to the muscles lying immediately on the bodies of the vertebræ. This perpendicular process is double. One part goes outward and backward, till it reaches the transverse processes of the vertebræ where it is attached or inserted, while the inner portion goes immediately over the rectus internus, capitis major and longus colli, across the bodies of the vertebræ, extending under the œsophagus, and is continuous with the corresponding layer of the opposite side.

The formation of the sheath for the great vessels of the neck now remains to be described, and may be easily understood, when it is recollected how the layers of the fascia are disposed. A covering is formed over the jugular vein by the fascia, where it is passing under the mastoideus. Then another slip passing from the anterior to the posterior division of the fascia, runs below the vein, and separates the jugular from the artery and par vagum, and the lower portion is formed by a continuation of the fascia under the carotid artery. From the centre of this lower part of the sheath, the double perpendicular process descends.

To demonstrate this most satisfactorily and easily, make an incision through the fascia under the mastoideus, in the course of the internal jugular vein—raising this covering of the vein, we should then take an inch or two of the vein from its bed, without wounding the parts below, and we shall see the slip of fascia separating the vein from the artery and par vagum. In like manner, if we cut through this partition and carefully raise the artery, removing an inch or two of the vessel, we then perceive the lower part of the sheath lying immediately under the par vagum and artery. By breaking through the lower part of the sheath, we may separate the layers of the perpendicular, or fifth and sixth processes.

SECTION III.

Formation of the Pericardium from the Fascia Superficialis.

The layer of the fascia superficialis, immediately covering the thyroid gland, described as the fifth process [p. 31.] passes under the sternum to the surface of the arteria innominata where it is joined by the outermost layer of this fascia, covering the lateral and back parts of the neck. Together they form a covering for the artery as it is passing between the scalenus anticus and medius.—Over the subclavian artery, from its inferior edge, the fascia extends outwards and downwards, running immediately below the subclavius muscle. Near the external edge of this muscle, we find the fascia superficialis continuous with that portion of the brachial fascia, which extends to the thorax under the pectoralis major.

We now cut away the cartilages of the four upper ribs on each side, and remove the sternum from the clavicles, having divided this bone transversely below the fourth rib. We are thus enabled to separate the upper part of the mediastinum and bag of the pleura from the pericardium. We then trace the fifth process or thyroid layer, (in union with the outer part,) of the fascia superficialis down to that part of the arch of the aorta, where the serous membrane of the pericardium is reflected to form the immediate covering of the heart. Then we clearly perceive, that the PERICARDIUM is formed from the *Fascia Superficialis,* which is uninterrupted and entirely continuous with the capsule of the heart. The serous membrane being cut through, we can raise the fascia from the surface of the aorta, down to the commencement of the fleshy fibres of the heart, with as much ease as we can elevate the outer or floating portion.

However, singular it may appear that this arrangement should not have been discovered until this time, it is by no means as singular, as that anatomists during so long a time should have remained contented to believe that a *serous* membrane like the PLEURA, could form a strong FIBROUS membrane like the PERICARDIUM!

If the descriptions here given appear difficult to those who have studied anatomy in the *usual* mode, we are sure that their surprise could only be equalled by their pleasure on witnessing the facility with which all these arrangements may be demonstrated and the beautiful simplicity of these structures incontestibly established.

SECTION IV.

Arrangement of the Brachial Fascia and formation of the Capsular ligament of the shoulder joint.

When we have removed the integuments and superficial fascia from the muscles of the shoulder and arm, we find a strong fibrous membrane covering the biceps, which has been hitherto considered as the peculiar fascia of that muscle. If we cut through this fascia directly over the centre of the biceps, in its length, and raise the portions towards the outside and inside of the arm, we perceive that this muscle is enclosed in a sheath very analogous to that formed for the sterno mastoideus in the neck, and the sartorius on the thigh. There is this difference, however, the fascia is not simply continuous beneath the muscle, but the outer and inner portions run towards each other, under the muscle and in the centre both portions penetrate its substance, where the two distinct heads may be said to cease and the single fleshy belly to begin. On the outer edge of the biceps, along the line of the humerus, we find the fascia attached to the bone, and where this attachment is cut through, we then see that it is continuous over the whole of the triceps, where its strength is increased.

Returning to the opening made over the centre of the biceps we may pass a knife handle under it, on the short head of the biceps, towards the scapula. This will lead us to remark, the manner in which this fascia as it passes along under the edge of the deltoid muscle is attached thereto, and also sends a delicate portion over the edge of the pectoralis major. But on raising the pectoralis major without removing the instrument passed under the fascia, we shall find the main sheet of fascia passing to the thorax, covering the pectoralis minor, going under the subclavius and clavicle into the neck, where it is continuous, with the fascia superficialis as before-mentioned. If we have pressed the knife handle upwards directly in the course of the short head of the biceps, we find the instrument reaching to the coracoid process, and by cutting the fascia open, thus far we see it continuing to the edge of the glenoid cavity, forming all of the fibrous part of the capsule of the shoulder joint.

To render the demonstration still more conclusive, cut through the deltoid muscle transversely immediately over the shoulder joint, being careful not to injure the subjacent fascia. Having cleared away the deltoid from about the joint, we return to the outer portion of the fascia, where it covers the biceps. There we find the fascia continuing over the inside of the arm to the triceps as before stated, and dissecting up this stronger portion, we shall be surprised and pleased to see how distinctly it runs up to the edge of the glenoid cavity and under the scapular portion of the deltoid, forming the whole of the capsular ligament. When the fascia is laid open, we have a beautiful view of the reflection of the synovial membrane and are thoroughly satisfied that there is no distinct or independent capsular ligament, but that this fascia forms the whole of what has been hitherto so called.

The fascia is attached strongly to the neck and inferior costa of the scapula at the upper part, but when this attachment is cut through we find the fascia forms a continuous sheet with the strong covering of the infra spinatus muscle.

The sheath for the brachial vessels is formed in a manner analogous to the formation of the cervical and femoral sheaths, that is by slips of the brachial fascia passing over the surface, between and below the vessels and nerves.

Resuming our examination of the brachial fascia, towards the elbow we find it continuing over the bend of the arm, receiving a considerable thickening from the lower extremity of the biceps and then being laid over the whole of the fore-arm forming distinct sheaths for the muscles, throughout analogous to the arrangement of the fascia lata. On the outside of the arm the attachments of the brachial fascia to the radius and ulna are strong, and the texture of the whole of the portion on the back of the forearm becomes much more dense, as it is employed in forming distinct sheaths for the muscles in precisely the same way as on the inside of the fore-arm.

SECTION V.

Arrangement of the Fascia Lata.

In examining this fascia, after having studied the arrangement of the fascia of the neck, the observer will be surprised and delighted to find that there is a most striking similarity existing between them, not only in the manner in which they relate to the muscles, but in the formation of the sheath of the vessels.

To begin this examination, we remove the integument and fascia superficialis from the posterior part of the nates, and are enabled to see how far the fascia lata extends on the ilium from the part which may be properly considered as its origin; being all the edge of the ilium not occupied by the origin of the glutæus maximus, out to that portion of the border of the ilium giving origin to the tensor vaginæ femoris, immediately behind the anterior superior spinous process. The tensor vaginæ is fairly enclosed between two layers of the fascia lata, which joining at the interior and inferior parts of the muscle, form that strongest part of the fascia denominated the *iliac* portion, or part covering the haunch.

This iliac portion advances very little at the upper part, before it again separates into two layers, the one going *over* the sartorius muscle, and the other under it. The superior layer is thinner than the common fascia, and allows us to see the muscular fibre through it—while the fibres of the muscle on the outer part of the thigh, are entirely hidden by the thickness and opacity of the fascia. In consequence of the separation mentioned, a beautiful sheath is formed for the sartorius, resembling in every particular that formed by the superficial fascia in the neck for the sterno-cleido-mastoideus.

If we cut through the layer covering the sartorius, in the direction of the muscular fibre, a short distance from its outer edge, and then raise this external portion towards the ligament of *Poupart,* we find that it reunites with the inferior layer just beyond the internal edge of the tensor. Let us now cut for the tenth of an inch through this union and we shall see the fascia again separating into two layers, having a considerable interspace, which in many subjects contains an appreciable quantity of fatty matter. This part of the fascia is situated anterior to the upper part of the sartorius, and would be contained in a triangle made by drawing

F

a line from the middle of the symphysis pubis to the sartorius, having the ligament of Poupart for the opposite side of the triangle, and the muscle for its base. Having made the opening required, we may then push the handle of the knife up to the lower border of Poupart's ligament, below the anterior superior spine of the ilium, and by continuing the pressure downward and inward, we may carry the instrument entirely to the extremity of that duplicature which is called the *falciform process*, semilunar process, or *Hey's* ligament, without using any violence. By this last view we are made acquainted with the manner in which the pubic portion comes up under the vessels to join the parts described.

Were our examinations to cease here, they would be of comparatively little value, however interesting the research might prove to the individual. But I flatter myself that the discovery of the peculiar arrangements of this fasciæ, will lead us at once to a better acquaintance with its physiology. The outer layer, or that part which may be considered as the continuation of the external part of the sheath of the sartorius, is *continuous* with the *tendon* of the *external oblique* muscle, which is thus enabled to act very advantageously on the fascia. The *fascia lata* is provided with a muscle whose peculiar business is to tighten this great sheath of the thigh; as the tensor vaginæ femoris is situated nearly in a line with the external condyle of the femur, which is by no means so low, or rather so long as the internal, of necessity, in tightening the outer part of the fascia to the greatest degree, it must relax the inner portion (covering the gracilis, adductors, &c.) at the upper and inner part of the thigh, which is by no means within its sphere of action. The arrangement mentioned, the continuity (of the external layer of the iliac portion) of the fascia lata with the tendon of the external oblique, compensates for the defect that would otherwise exist, and tightens the part of the fascia lata covering the upper and inner part of the thigh. In saying that the fascia is continuous with the tendon of the external oblique, we do not say that no connexion exists between the internal and external layers, just where the outer one joins the tendon of the oblique. But this union is effected by a very delicate portion, not much more than perceptible, while the junction between the outer layer of the fascia, the continuity with this tendon, is fair and strong, perfectly visible and palpable. To prove how thoroughly this arrangement serves the purpose mentioned, it is only necessary to make a slight pressure on the external oblique, or to pull its tendon with the forceps when the subject is placed on its back, and the integuments and fascia superficialis are removed. We shall then be convinced that a very slight contraction of the muscle is capable of affecting the state of tension of the fascia lata on the inner part of the thigh.

The arrangement of the internal layer forming the under part of the sheath for the sartorius is very interesting, and in relation to the formation of the sheath for the vessels, precisely similar to that of the third layer of the superficial fascia in the neck. At the outer edge of the *sartorius* the fascia splits, to send one portion outwards and backwards over the surface of the muscles, while the inner portion doubling inwards and forwards, runs under the sartorius muscle. It may be considered as the continuation of the external layer—and after thus forming the sheath of the sartorius, it runs onward to cover the great artery of the thigh, just at the inner or pubic side of which, the iliac and pubic portions of the fascia are united.

We may now with great facility raise the layer going over the artery. Then we may raise any portion of the artery from its bed, leaving the process between the artery and vein—after this we can raise this portion, cut and lift up a part of the femoral vein, and show the lower part of the sheath strong and fair, going beneath it. From the lower part of the sheath, we find a single perpendicular process going down to be fixed into the linea aspera.

The fascia lata forms all the sheaths for the muscles of the thigh, and continues to form the sheath of the vessels after the artery has passed through the tendon of the triceps. The pubic portion near the ligament of Poupart, passes under the great vessels, and is connected or rather continuous with the fascia transversalis or interna. This part of the investigation must be left until we give a description of the researches made relative to the internal fascia.

However difficult the study of the fascia lata may appear from the description, it is by no means so difficult to comprehend when it is examined with the knife. When studied in the manner here directed, the satisfaction derived from the clearer understanding of the physiology of all the neighbouring parts, will more then compensate for the difficulties surmounted by the application necessary to see all that is described. The important influence exercised by the processes of this fascia (forming sheaths for the vessels and muscles) over various surgical diseases and operations, can only be perceived by one who is thoroughly acquainted with its true character, extent and connexions. The establishment of the fact that there is but one fascia forming all the processes about the neck, and another all those of the thigh, and that in both the sheath for a particular muscle as well as the sheath for the great vessels are formed in the same manner, is a circumstance of very interesting character and may lead us still farther in our researches concerning the various parts they surround or separate.

SECTION VI.

Arrangement of the Fascia Interna Abdominis, and formation of the capsular ligament of the Hip Joint, from the Fascia Lata.

The fascia which is at present to be described has hitherto only been examined at particular points and under different names, in consequence of which much confusion has been produced and the difficulties of acquiring an accurate knowledge of its relations needlessly augmented. The *fascia transversalis, fascia iliaca, fascia prostrata, fascia pelvica,* are all parts of the *same* fascia, which bears a sufficiently close resemblance to the fascia superficialis in the manner of its application to the whole of the cavity of the abdomen and pelvis, to justify us in bestowing on it the name of FASCIA INTERNA ABDOMINIS, in contra-distinction.

The FASCIA INTERNA, lies between the inner surface of the abdominal muscles and peritoneum. To examine it most satisfactorily, after having removed the external portion of the sheath of the rectus below the navel, and raised this muscle from its bed, make an incision from the umbilicus to the anteriour superiour spinous process of the ilium, through the abdominal muscles. This cut brings us down to the strongest part of the fascia interna. We then clear off the abdominal muscles without wounding the fascia so as to expose all the iliac and hypochondric regions, and to the edge of the sheath of the rectus near the median line of the body. If we make a small hole through the fascia interna, midway between the spine of the ilium and umbilicus, we may introduce a knife handle between this fascia and the peritoneum and separate them from each other throughout the lateral and back parts of the abdomen, till we have passed over the liver to the under surface of the diaphragm. Having thus raised the fascia interna, we may by blowing into the opening inflate the sac and exhibit it fairly detached from the peritoneum. Making an incision through the fascia in the same direction as the first cut through the muscles and cutting from the crest of the ilium to the last rib, we turn this upper flap over and follow it towards the centre, under the inner portion of the sheath of the rectus. Here we find it more closely attached than at any other part both to the tendon of the transversalis and the peritoneum, yet by careful dissection it may be fairly separated from both, without wounding either, so as to show its continuity entirely across the anterior part of the inner surface of the abdominal muscles.

The fascia interna is attached with firmness to the whole of the crest of the ilium from the anterior superior spinous process backwards; it also is fixed to the transverse processes of the loins, where it forms the covering of the quadratus lumborum, and also separates this muscle from the external muscles of the back.

Returning to the lower portion of the fascia interna we raise it from the anterior superior spine of the ilium to the pubis, and in doing this we have a beautiful view of the internal abdominal ring, the space by which the spermatic cord goes through this fascia to emerge on the pubis after passing through the tendon of the external oblique or external abdominal ring. This is the portion of the fascia *interna,* heretofore called fascia *transversalis,* and whose real character is of so much importance to the surgical practitioner. This part of the fascia interna fills the vacancy that would otherwise exist between the inferior edges of the internal oblique and transverse muscles and the edge of the pelvis, and was called fascia transversalis because it was thought to be continuous with the transverse muscle.

Below the internal abdominal ring the *fascia interna* touches the ligament of Poupart to which it is attached, but it does not cease there, being continued down on the great vessels of the thigh. It is usually stated that the fascia interna is here so arranged as to descend in the form of a funnel for a certain distance before and behind the great vessels; to be reflected at the distance of three-fourths of an inch below Poupart's ligament and thus to prevent any communication between the pelvis and top of the thigh. This is very far from the true state of the fact; the FASCIA INTERNA is *indubitably continuous* with the *fascia lata* femoris, both on the superior and inferior surface of the great vessels, concerning the sheath for which we have spoken in a preceding section, and the communication is prevented by cellular attachments. To be convinced of this, let us return to the crest of the ilium, and cut through the attachment of the fascia interna to the bone. We find this attachment to be a short perpendicular process, which when cut through leaves the continuity of the fascia interna and the covering of the internal iliac muscle uninterrupted. This last portion is what has been heretofore named the *iliac fascia*. We raise the fascia *interna* from over the iliac muscle towards the edge of the psoas magnus, where it separates so as to form a sheath for this muscle and afterwards goes to the common iliac artery, below, and directly in a line with which the fascia interna is attached to the linea ileo pectinea and to the bodies of the lumbar vertebræ.

Now cut up the pubic extremity of Poupart's ligament and reflect it carefully towards the anterior superior spine. Then follow the iliac portion of the fascia interna downwards till it passes under the vessels and together with the superior portion forms the funnel shaped process of Professor Colles.* We now find this lower or iliac part of the *internal fascia* is perfectly continuous with the *fascia lata,* and we may be still more clearly satisfied of this, by cutting across and removing about an inch or so of the femoral artery, which exhibits this continuity without turning the fascia interna from its place. The cellular attachments which prevent the communications between the pelvis and top of the thigh are also now made evident.

From the pubic extremity of Poupart's ligament we find the fascia interna passing into the pelvis where we shall presently find it forming the anterior ligaments of the bladder and triangular ligament of the urethra, while a process which goes down over the levator ani and obturator internus, forms the fascia of the prostrate gland.

But the most interesting and surprising part of the arrangement of these fasciæ is the manner in

* See his excellent treatise on Surgical Anatomy.

which the *great capsular ligament* of the thigh bone, is formed from the *fascia lata femoris,* which we could not well explain until the fascia interna had been described. If we trace the fascia lata upwards from between the vastus externus and gluteus maximus, we follow it over the great trochanter, and see it extending over the edges of the glutæus medius and minimus. This will give us the external layer of the outer part of the capsule. If we cut up the head of the rectus femoris (from the anterior inferior spinous process) we shall find the lower part of its sheath forming the outer layer of the anterior part of the capsule. Raising this portion, and then cutting through the lower part of the sheath of the femoral vessels, (so as to get between the parts going towards the inner and outer parts of the thigh,) we raise the outer portion to the capsule so as to show how it forms the middle part of its thickness. If we now return to the pubis and cut through the pubic portion of the fascia down to the bone, we raise this part, (which is continuous with the fascia interna,) towards the joint, and thus uncover the anterior part of the joint, with the exception of the delicate synovial membrane. Thus we are satisfied that this powerful capsule derives all its strength from the successive additions of the *fascia lata,* and has no existence as a separate or independent ligament.

SECTION VII.

Irregularities of Structure.

Departures from the ordinary structure in the human body are much more numerous and frequent than is generally imagined. But as few persons are exclusively devoted to anatomical research, the opportunities of collecting a sufficient number of observations to lead to any important general conclusion are rare, and the facts are seldom recorded, because they are observed at distant periods and excite but a temporary interest.

If we were now in possession of a carefully observed and fairly written statement of all the aberrations which have been examined since anatomy has been correctly studied, we should doubtless be enabled to draw some general conclusion of practical utility, no less than to explain many pathological circumstances which still continue to be mysterious. Previous to the systematic essay of Dr. Duncan on the malformations of the urinary and genital organs, published in the Edinburgh Journal it was supposed that each irregularity had an individual and appropriate character, which made the case merely an object of curiosity. By an examination of his paper it will be seen that a very striking similarity existed in the cases he observed as to the manner in which nature accommodated the system to the defective organization. Almost all the cases related in the periodical papers since Dr. Monro's essay are similar to some of those he has described. or are species of the same genera.

In order, therefore, to induce others to communicate the results of their experience, I shall attempt to arrange the instances of irregularity which I have witnessed in various parts of the body, hoping that those who are possessed of similar observations will be induced to contribute them for the general good.

I.—The Osseous System.

In this system, there is seldom any irregularity of structure. All the departures from the ordinary arrangement in the cases I have examined were the the results of accident or constitutional disease. These accidental appearances, or results of morbid action are very numerous, and to be considered in another place.

II.—The Muscular System.

We observe a considerable number of interesting and peculiar irregularities in this department. Some muscles, as the pyramidales the palmaris longus, zygomaticus minor and plantaris are frequently deficient, and the proper motions or actions do not appear to be injured in consequence. It does not often happen that any attempt is made by nature to compensate for their absence ; in one case, however, where the palmaris longus was deficient, I found a considerable strip of muscular substance arising from the annular ligament, just above the wrist, and ascending one third of the forearm, to be attached to the common fascia.

In one instance, instead of the usual arrangement, the muscle corresponding to the serratus major anticus, whose office is to draw the base of the scapula downwards, inwards, and forwards, took its origin by two distinct portions from the lateral conversity of the second, third, and fourth, and from the sixth, seventh, and eighth ribs, and these portions were inserted separately into the inferior angle of the scapula, and into the base, from the superior angle only to the extremity of the spine, leaving an interspace of three inches.

The biceps brachii flexor in three bodies examined about the same time was found to have an additional slip or third head coming off from the inferior third of the os humeri along the line extending to the inner condyle. This slip was half an inch in breadth, and was inserted into the fascia, going from the tendon of the biceps over the flexor and pronator muscles, arising from the inner condyle. In these three cases the origin and insertion of this slip was precisely similar. In a fourth and fifth case presented a few days after, a distinct and beautiful fleshy belly arose about half an inch above the origin of the brachialis internus, fairly separated from it and the biceps by cellular substance. This extra portion continued distinct until near the elbow joint, when it was inserted into the under surface of the common tendon of the biceps.

The MUSCLE of the **THYROID GLAND**, was found in the Philadelphia anatomical rooms, twice during the winter and four times during the month of March (1824.) The first instance was observed by a member of my class, Mr. *Alfred Hartwell*, of N. C. In four of these cases the muscle was on the left side, arising from the upper edge of the left lobe, and going up to be inserted into the os hyoides halfway between the base and appendix of that bone. In the other two instances the muscle

✣ Muscle of the Thyroid Gland.

J. Drayton Sc.

arose from the centre of both lobes, through their whole extent, and was inserted directly into the centre of the base of the os hyoides.

This singular muscle arising from a GLAND and inserted into a *bone,* was first described by SOEMMERING, and is said to occur once in five hundred subjects. Dr. HORNER mentions in his Anatomy, that he has not met with it in an experience of many years. From the results of our observations during the last session, I am inclined to believe that it occurs at least in three cases out of five, if it is not to be found in every case. That it may be very easily overlooked when it is confined to the left side, is not surprising when we observe that it runs almost directly in the same course with the thyrohyoideus, from which it is separated only by very delicate cellular substance, and the portion extending below the origin of the muscle last-mentioned so nearly resembles in colour the ordinary appearance of the membrane covering the gland, or the gland itself. Certain it is, that since our attention has been called to the subject, this muscle has been found in every body examined for the purpose.

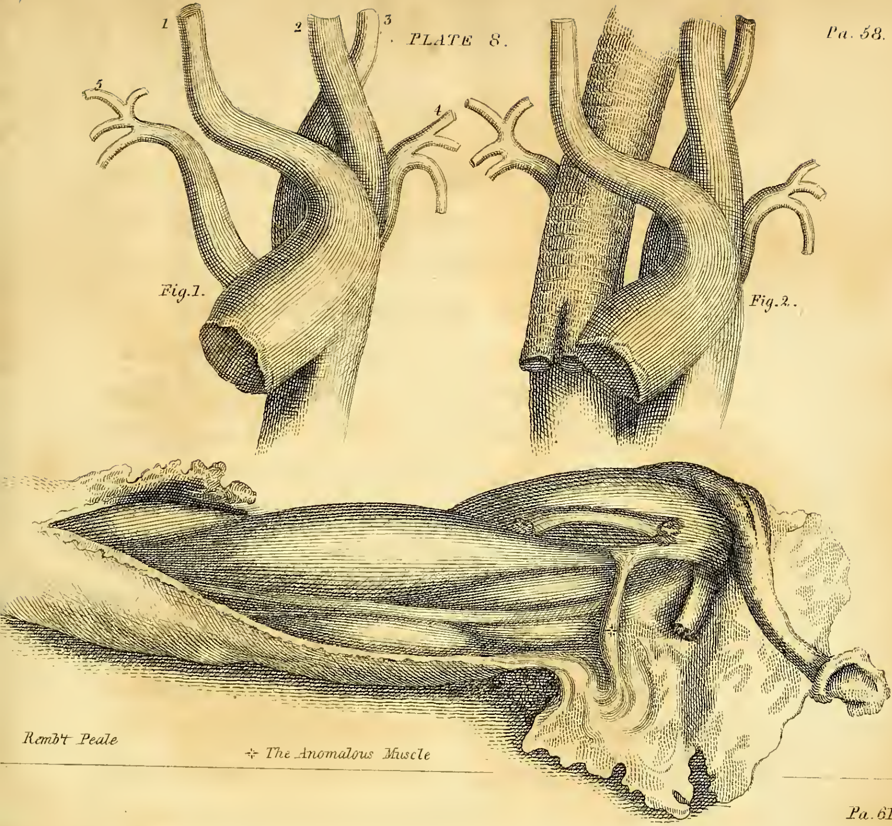
The most singular sport of nature, in the muscular system, which has fallen under my notice, is one which occurred in a subject very carefully dissected by one of my class, Mr. Isaac Brinckerhoff of N. Y.

This muscle arose from the fascia covering the latissimus dorsi and teres major, just within the border of the axilla, and ascended to be inserted by a beautiful tendon into the coracoid process of the scapula, between the insertion of the pectoralis minor and the shorter head of the biceps. A delicate sheet of silvery tendon extending from its insertion over to the edge of the biceps. This muscle which was about two inches long crossed the axilla beneath the brachial plexus, as may be seen in the admirably correct delineation of it by Mr. Rembrandt Peale, (p. 8.) What purpose it served it is not very easy to perceive; it could have tightened the fascia over the latissimus and teres, but this is not very necessary as we never see any instrument particularly designed to produce such an effect. It is nevertheless singular, that a structure so purely accidental should be formed with such perfect symmetry and regularity.

III.—The Arterial System.

The irregularities of the arterial system have been more attended to, than those of any other part of our structure. The most remarkable instance I have met with was in an infant subject dissected by Mr. Robert Young of Indiana, Pa. The arteries instead of going off from the arch of the aorta in

PLATE 8.



Rembt Peale

+ The Anomalous Muscle

PLATE

Lesueur

J Drayton Sc.

the usual manner, came off thus; 1st, the right carotid artery, 2d, the left carotid artery, 3d, the left vertebral artery, 4th, the left subclavian, 5th, *the right subclavian*. The right carotid artery crossed over the trachea to get to the right side of the neck; the right subclavian arose from the *back part* of the aorta after it had described its curvature, running *behind the œsophagus and trachea* towards the edge of the clavicle. The left vertebral artery not less singular in its origin, began from *the arch of* the aorta just behind and below the left carotid, instead of being given off by the left subclavian; the only instance I ever saw of such an origin to this vessel, though I have read of two or three cases somewhat resembling it; this subject was injected and the drawing was made very carefully; there were possibly some singularities in the venous system, but my attention was not called to this subjeet until the rest of the structure was removed to exhibit the arteries, (plate 8, fig. 1, 2.)

During this winter, (1823–4,) we found *three* instances in which the ARTERIA INNOMINATA gave off the *right and left carotids* and the right subclavian artery. This distribution cannot be exceedingly rare, since we have found it so often during a single session, and moreover, in subjects injected for the purpose of making anatomical preparations alone, comprising a very small part of the whole number of subjects dissected.

If the operation of tying up the arteria innominata were performed on a patient, in whom the arteries were thus distributed, what would be the immediate consequence? The whole amount of the circulation would at once be cut off from the right arm, from the upper and central parts of the right side of the thorax, from the whole of the anterior of the neck and the parts about the tongue, the whole of the face and scalp, and from the whole of the anterior part of the brain. The only blood which would flow directly to the brain would be by the left vertebral artery, which as it ascends to the brain through the long canal formed in the transverse processes of the cervical vertebræ, could scarcely be dilated sufficiently to carry the whole quantity of blood necessary to this organ. The inosculations of the left ascending thyroid—of the lower intercostals, of the epigastric, with the internal mammary—and of the dorsal branches with the cervical vessels, would form nearly the whole chance of the preservation of the arm, neck and face, allowing that *one* vertebral artery could convey blood enough for the brain. The possibility of this distribution should at last make us cautious of recommending this operation, without having most attentively examined all the chances of its failure; even though ever so correctly performed.

In one instance there was found a singular communication existing between the right colic artery and the hepatic, a trunk as large as the original artery continuing from the one to the other.

A very interesting case of high bifurcation of the femoral artery, was met with during the month of March, in an adult subject, whose vessels were injected. What renders this case more peculiar is that we find the same distribution on both sides, the profunda femoris being given off at a very short distance below Poupart's ligament, and the circumflexa externa arising as a large distinct trunk from the femoral, all these branches lying immediately under the fascia lata. On the left side of this body, the arteria obturatoria was given off by the Epigastric. The dissection from which Mr. Lesueur made his drawing was very carefully prepared by Messrs. Price and Comstock, members of the class.

SECTION VIII.

MORBID ANATOMY.

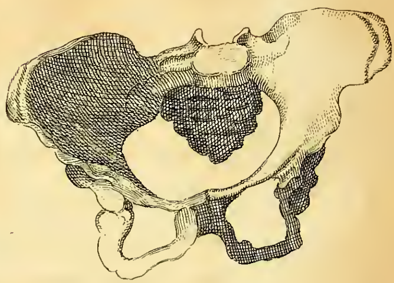
Oseous System.

One of the most singular appearances met with during this season, is the distorted pelvis of which views are given in plate 5.

It seems to have arisen from the dislocation of the pubic bones, by means of which one is made to project beyond the other, so as to give a sharp prominence both on the outer and inside of the pelvis. The degree in which this displacement affected the diameters of the pelvis is very accurately figured by Mr. Lesueur's drawing. The right kidney lay considerably within the ilium over the iliac muscle. The left was not so low but considerably lower than ordinary. The cartilage at the symphysis although so much distorted appeared to be very little different from the natural condition, and no idea could be formed of the cause producing the deformity. The womb of this subject was also diseased as will be hereafter described.

PLATE 5.

Pa. 62.



sueur

PLATE 6

Pa. 63.

Drawn & Eng'd by J.Drayton.

Plate 6, gives a representation of a very interesting case of exostosis, occurring in the body of an old woman apparently 65 years of age. A part of the large mass near the lower extremity projected through an immense ulcer of a very disagreeable appearance. The whole extent of these bones is covered by the sharp irregular spines, which give to the fibula a considerable resemblance to a stalactite. In other respects this subject showed nothing extraordinary, nor had we an opportunity of forming any opinion as to the cause producing the diseased appearance of the bones. It may have been owing to the effects of venereal taint.

In another instance, the lower part of the femur, the tibia and fibula were enlarged and gibbous through their whole extent, and in this case, there was sufficient reason to believe that the immediate cause of the evil was the venereal disease.

A highly interesting result was obtained by examining the body of a female who had perished by falling into the fire during an epileptic fit. The viscera of the chest, abdomen, &c. were perfectly natural. Within the head a bony tumor was found growing from the internal surface of the scull cap, about half an inch from the longitudinal sinus, and which encroached on the brain nearly half an inch. On separating the hemisphere so as to examine the falx a large irregular ossification, was found upwards of three fourths of an inch in length projecting on both sides so as to press considerably on the brain. In the course of the longitudinal sinus, several spiculæ very singular and pointed, presented their cutting edges toward the brain. A view of those ossifications is given in the plate. One side of this scull was much less convex than the other, as if it had been flattened in early life by long continued pressure.

I have dissected the head of a black man whose scull was as well shaped as the generality of persons of colour. He had been lunatic during several years previous to his death, and on dissection, the falx of the dura mater was found to contain three considerable patches of ossification. The membranes of the brain, showing evident appearances of having been inflamed shortly previous to death, but it was not possible to determine whether the ossification had been the immediate exciting cause of the inflammation.

Muscular System.

The only morbid appearance observed in this system, was the change of the gastrocnemius and soleus of one leg, into a substance somewhat resembling a mixture of ligament and cartilage, having no trace throughout of proper muscular struc-

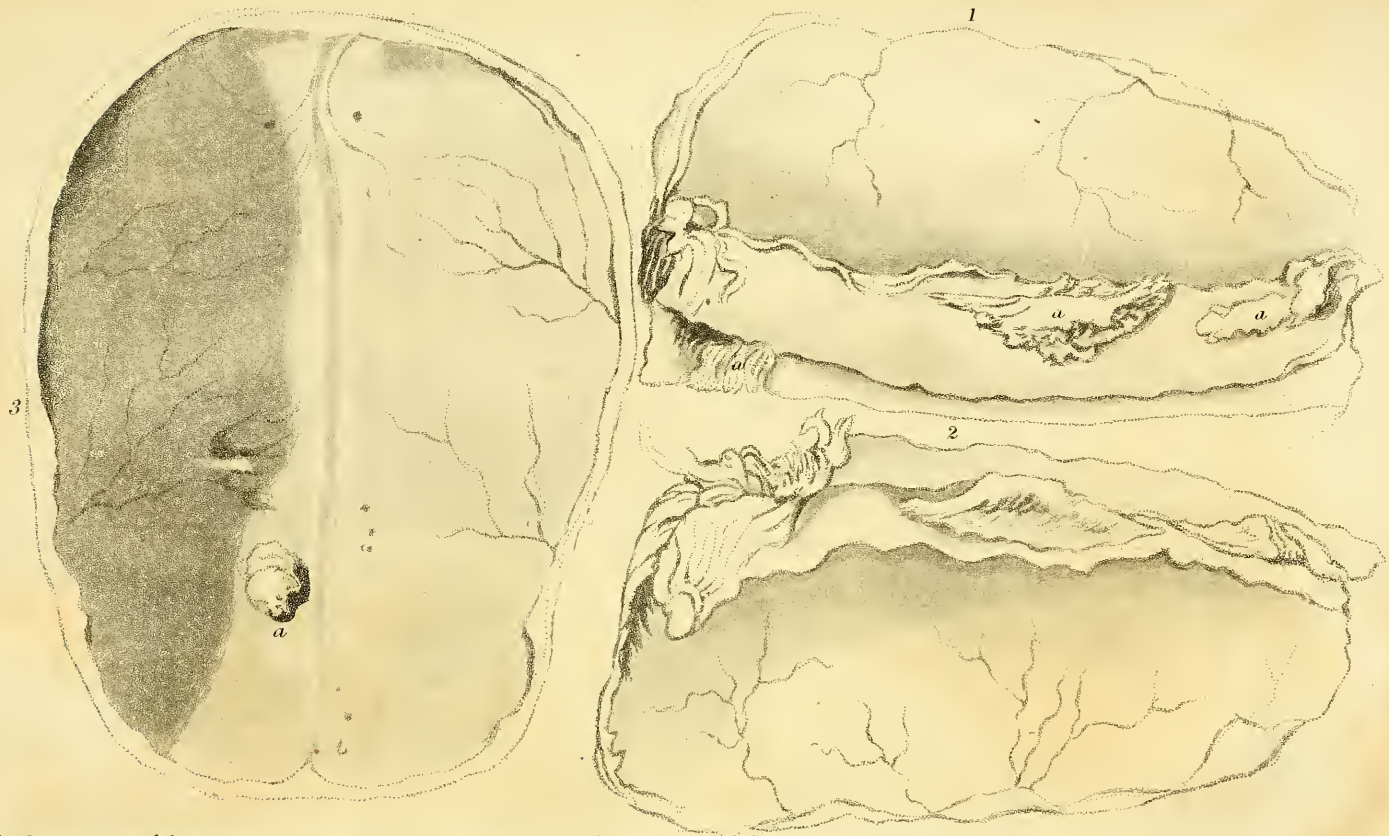


Fig. 1. 2. a.a.a. **Ossifications** *in the* **Falx** *of the* **D. Mater**, *shewn on both sides.* | *Fig. 3. a.* **Ossification**, *growing from the inside of the* **Scull.**

ture. In colour it differed but little from the common appearance of the tendo achillis, when it has been for a short time exposed to the air.

Arterial System.

The most frequent alteration observed in the arteries was the deposition of bony matter in their coats. This generally was found in greatest quantity in the aorta. In one instance it extended to the arteries of the brain and indeed throughout the body. But in the brain all the vessels down to such as were not much larger than a bristle or horse hair, were almost entirely bony.*

Venous System.

The veins were in many instances in a varicose state especially in the inferior extremities. The vessels were much more varicose when they were seated between the skin and fascia of the leg. After passing under the fascia, the veins were seldom as much diseased as where they were not subjected to this pressure. In two cases of varicose veins of

* In a case of general or at least very extensive ossification of the capillary vessels, how could the circulation be continued, according to the notions of those who think the capillaries possess the power of propelling their contents, independent of the heart?

the leg, encysted melicerous tumours were found near to that part of the adductor which is perforated by the artery.

Respiratory System.

Many cases of tuberculous lungs were examined and a great variety of appearances indicative of their different states remarked. In several instances the whole hemisphere was found *hepatized* or resembling the liver in texture, while only a small part of the opposite hemisphere remained fit for the purposes of respiration.

In one case a body was examined which externally exhibited no peculiarity, and the whole body seemed plump and fleshy, on examining the chest, on the left side instead of lung was found a large irregular sac, apparently made up of the pericardium and pleura massed together, filled with a bloody and offensive fluid. There was no peculiarity in the right lung.

From the appearance of the sac and the state of the lung we should hardly suppose that the changes could be effected in a short time, yet the quantity of fat and the general fulness of the body seemed to indicate any thing rather than long continued disease.

Digestive System.

Diseased appearances of the stomach were not very frequent. Effusions and adhesions were often found in different parts of the belly. In some cases there were well marked evidences of general inflammation of the bowels. One of these cases was very interesting on account of the great extent of the mischief produced in consequence of the inflammation.

The whole of the abdominal viscera were so massed together as to render it almost impossible to separate the parts without cutting through them. The liver was uncommonly enlarged, the left lobe compressing the stomach and the right thrusting the bowels towards the centre of the abdominal cavity. The convex surface of the liver had elevated the diaphragm to the greatest degree it was capable of, and it was evident from the slight effects produced by very considerable pressure, that the motion of the diaphragm must have been almost entirely suspended for some time before death. Throughout the whole of the abdomen, and between the lamina of the mediastinum there were tubercles resembling glands in appearance, from the size of a small pin's head, up to the magnitude of a large walnut. The lungs were very much compressed, not only by the enlargement of the liver and elevation of the diaphragm but by the large quantity of fluid effused in the cavity of the chest and pericardium. The brain also contained a considerable quantity of fluid, but gave no well marked traces of inflammation. In such a case, it is wonderful that life should have been continued during a period sufficiently long to allow these changes to take place. I have dissected one subject, a mulatto female, about 24 or 25 years of age, in whom something of a similar displacement of the thoracic and abdominal viscera, had been produced by tight lacing. The ribs and cartilages were so much drawn in as to give quite a conical appearance to the lower part of the chest.

On inspecting the cavity of the abdomen the liver, stomach and spleen, were much elevated and the diaphragm so much pushed up as to encroach considerably on the lungs. When the upper part of the thorax was examined, a very large portion of the apex of the lungs extended above the clavicles, under the scaleni, within the triangle of the pleura which under ordinary circumstances is quite small. It seemed as if the system had made an effort to compensate for the loss of space in the thorax produced by the encroachment of the abdominal viscera on its cavity. The impediment thus produced to the proper passage of the blood through the lungs, the hindrance of the motions of the diaphragm, and the disturbance caused in the stomach and liver, must convince every candid examiner of the pernicious tendency of this preposterous mode of dressing.

Excretory System.

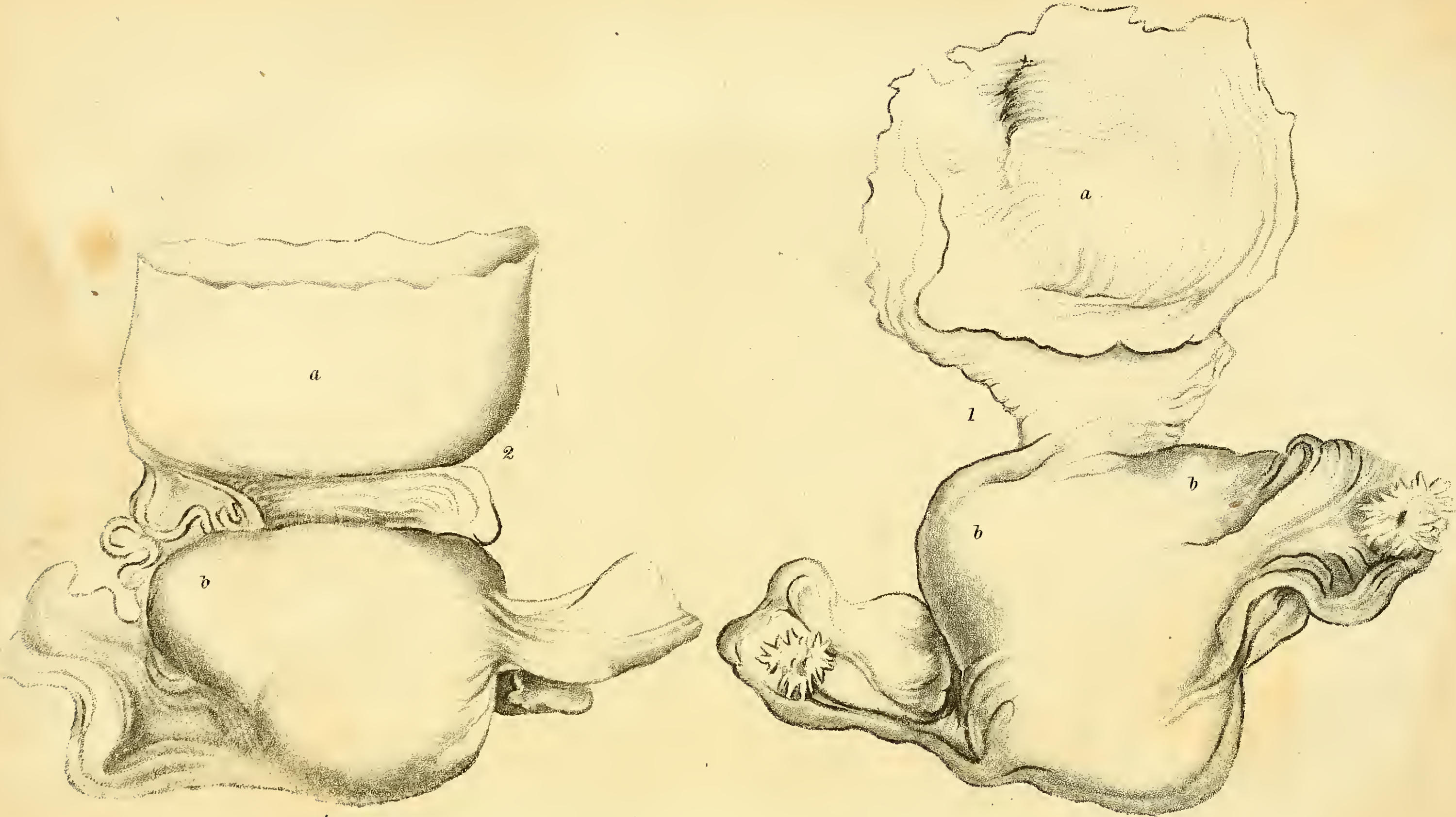
In an old female subject, an appearance of pus in the vagina led to the scrutiny of the uterus as being the probable seat of an abscess. But instead of an abscess, there was a fistulous opening through the posterior wall of the uterus, and this opening was found to be continuous with a long fistulous tube extending from the pelvis of the right kidney. At the commencement of the ureter a calculus had become so fixed as to prevent the flow of urine, though it did not entirely fill up the ureter. The consequence had been the ulceration of the pelvis of the kidney and the eventual establishment of this outlet through the vagina. It is not difficult to suppose that a case of this kind must have been attended with a great deal of distress, and it is very probable that all the treatment was directed to the uterus. This must have been totally ineffectual as the cause was so little connected with this organ. We have no diagnostic which could enable us to determine with any thing like certainty, the true seat of such a disease.

Genital System.

Several highly interesting cases of diseased womb were met with; two of them we have been enabled to preserve. The first occurred in the body of a female whose distorted pelvis is figured in plate 5, and a sketch of the diseased womb is given in another plate. At first sight this womb appeared to be double, but on examination this appearance was discovered to be owing to two fleshy tumors growing from its sides, and lying between the layers of the lateral ligaments, about two inches in length by one in breadth. They had no openings into their substance. Some small fleshy bodies hung from the internal surface into the cavity of the womb, resembling polypi by their slender necks and broad pendulous extremities.

The other case, figured in plate 5, is a globular tumor growing out of the posterior wall of the uterus, nearly filling its cavity. Previous to making an incision through the walls, this uterus had all the external appearances of being impregnated, or containing an ovum, six weeks developed.

Some bodies about the size of a small rifle ball were found between the layers of peritoneum forming the broad ligaments. Externally they were quite smooth, hard and white, and when closely



Diseased Uterus. *Fig. 1. front view Fig. 2. back view. a.a. bladder, b.b. the tumors.*

examined were seen to be entirely composed of bony matter. A substance in every respect similar was found in the neighbourhood of the emulgent vein of the right side in the same subject.

If we recollect how small a proportion of the bodies which annually die are dissected—and how small the number of those dissected are *thoroughly* examined, we need not feel surprised that so many irregularities of structure are presented, or that anomalies should occasionally be observed. Perhaps a more universal and careful examination of the dead will hereafter convince us, that what have heretofore been recorded as irregularities, may occur too frequently to permit us even to consider them as exceptions to a general rule. It is much to be hoped that physicians will improve every opportunity of making careful examinations by dissection, and thus fix pathology on the only basis which can withstand the destructive influence of change and time. In our large cities very praiseworthy efforts to collect such knowledge are daily made, but to be useful, the practice should be universally diffused.

SECTION IX.

THE HYMEN.

No better proof can be given of the imperfect manner in which observations are made, or the precipitancy with which conclusions have been drawn concerning structure, than is exhibited in the history of opinions relative to this membrane. Some persons have found it in almost every instance, others have never been able to see it—one party has declared it inseparable from the condition of youth and virginity—another, that it never had an existence. Among foreign writers the discussion has been for a long time kept up, and in this country opinion is not altogether settled. A paper was read to the Medical Society of Philadelphia by a gentleman of large experience, during the last session, in which the very existence of this membrane was denied, and the origin of the general opinion ingeniously accounted for. Three days after the reading of this paper a female subject about twelve years of age was brought to the rooms. On examination, the hymen was found

HYMEN.

J. Drayton Sc.

very perfect, and corresponding in all things to the descriptions heretofore given by anatomists. In consequence of the doubts which had been excited by Dr. Rousseau's paper relative to its existence, I had a drawing made of it in its recent state by Mr. C. A. Lesueur, (whose name is synonymous with truth in all that pertains to graphic delineation,) and the whole genital apparatus was carefully preserved in spirits by Mr. Leybura the attentive student to whom the subject belonged.* This was the third instance in which the hymen was found entire during this session. The first was in the body of a black girl between fourteen and sixteen years of age, and the second in the body of a female infant about three years of age. As the last two cases occurred sometime previous to the reading of the paper that reiterated the doubts of the existence of the hymen, no drawing was made, nor were the parts preserved.

Although there can be no doubt of the regular existence of the hymen, still its existence is not proof positive of spotless chastity, as women have been impregnated without rupture of this membrane and

* The preparation made by this young gentleman of the whole subject is one of the most admirable display, of the arterial systems in its minuteness, that I have ever seen. The cabinets of Philadelphia, New York, and Baltimore, which I have examined contain no preparation that can be compared with this as a *whole.*

many instances are recorded in which pregnancy was produced notwithstanding the existence of an external malformation, utterly forbidding the introduction of the male organ. This fact, unfortunately for some ingenious theorists on generation, is too well established, to suffer their speculations to be credited.*

* "The Hymen (so named from the Greek word ὑμην, a membrane,) is formed by four angular duplicatures of the membrane of the vagina, the union of which may be discovered by corresponding lines on the hymen. At the upper part there is a semilunar vacancy, intended for the transmission of the menses, so that it assumes the form of a crescent; a circumctance which affords the true explanation of the origin and meaning of the symbol so characteristically assigned to Diana. In some rare cases, the hymen is an imperforate circular membrane, attached to the edge of the orifice of the vagina in every part, so as to close the canal completely. The girls, in whom this fault of confirmation existed, were called by the Greeks ἀτρηται; the physicians who have written in Latin amongst us have given them the name of *Imperforatæ, clausæ*, or *velatæ;* and the Italians that of *Coperchiate.* The Romans had no appropriate word to denote this malformation, and they were therefore obliged to express it by some circumlocution: it is thus that Cicero (*De Divinat.* lib. ii.) speaks of a dream, where a woman was seen "*quæ obsignatam habebat naturam;*" and that Pliny (*Hist. Nat.* lib. vii. c. 16.) relates, Cornelia, the mother of the Gracchi, "*concreti genitali nata fuerat.*" In many cases the membrane appears never to have been formed; while, in others, its extreme tenuity has occasioned its rupture and destruction in early life: it may, moreover, have been destroyed by disease, by

In addition to what we have demonstrated relative to the hymen in the human female, it may be of advantage in ending all doubt on this subject, to

noxious habits, or by acrimonious discharges. This extreme uncertainty has led many authors, of no inconsiderable eminence, to deny its existence; while others have acknowledged its occasional presence, but have attributed its formation to disease. Graaf, Penius, Buffon, Dionis, declare that, by dissection of girls of all ages, they have never been able to discover it: on the other hand, the reality of this membrane has been maintained by Berenger de Carpi (*In Isagoge Anatomica,*) Vesalius (*De Corp. Huma. Fabric.* v. c. 15,) Fallopius (*In Observat. Anatom.*) Voleherus Coiterus (*In Tabul. Anatom.,*) Varolius (*Anatom.* lib. iv. c. 4,) Riolanus (*Anthropog.* lib. i. c. 16,) Bartholin (*Anat.* lib. i. c. 31,) Weisus (*Observat.* lib. i. *et de Lamiis* lib. iii. c. 20,) Spigelius (*De Hum. Corp. Fabrica,*) lib. viii. c. 18,) Diemerbroeck (*Anatom.* lib. i. c. 16,) Swammerdam (*De Uteri Mulieb. Fabrica,*) Techmeyer (*Institut. Medicin. Legal et Forens.* c. iv.,) and all the more learned and able anatomists of the sixteenth and seventeenth centuries. Heister (*Compend Anatom.* and *Ephem. Nat. Curios. Cent.* viii. *Observ.* 69,) Frederick Ruysch (*Thes. Anatom.* iii. no. 16; vi. no. 1; vii. no. 60,) Morgagni (*Adversaria Anatom.* i. 29; iv. 23,) and Winslow (*Exposit. Anatom.* no. 653,) all describe this membrane, and assert that they have found it in every young girl they have had occasion to examine. Astruc (*on the Diseases of Women,* vol. i. p. 123,) in referring to the above learned authorities, observes that "the inference must necessarily be, that those who deny ever to have seen it, must either have examined only such girls as had lost their virginity, or prepossessed with the false notion that the hymen must always close the entrance to the vagina entirely, they have mistaken it at the time subjoin the following statement of the existence of this membrane in inferior animals, from a work of high authority in natural history.

"This singular character does not exclusively belong to the female organs of the human species. It is now ascertained that all female mammiferæ, previous to copulation this sign of virginity present in different degrees; and hence, it is not as Haller supposed for a moral reason that the membrane has been given to women. A strong fold of the lining membrane of the vagina has been observed in female elephants, before they have brought forth. Steller has made the same observation on the females of the seal and the lamantin of the

it was before their eyes, and have even sometimes given the description of it, without mentioning the name." After this literary history of the question, we may very safely conclude that the hymen is a perfectly natural structure, occurring in the virgin, and that by sexual intercourse it is ruptured; after which it is shrivelled into several small excrescences at the orifice of the urethra, called the *carunculæ myrtiformes*. But, since it is liable to such variations in appearance, and to accidental rupture, from the slightest causes, its absence can never be received as evidence of defloration; nor can its presence be considered as an unequivocal proof of virginity; for it has been asserted by indisputable authority, that it is not always ruptured *in coitu*. Ruysch has said, that, if the coitus take place immediately after the menstrual excretion, this membrane is not ruptured, (*Observ. Anat. Chirurg.* xxii.) See Lond. Med. and Phys. Journal, p. 211. vol. li.

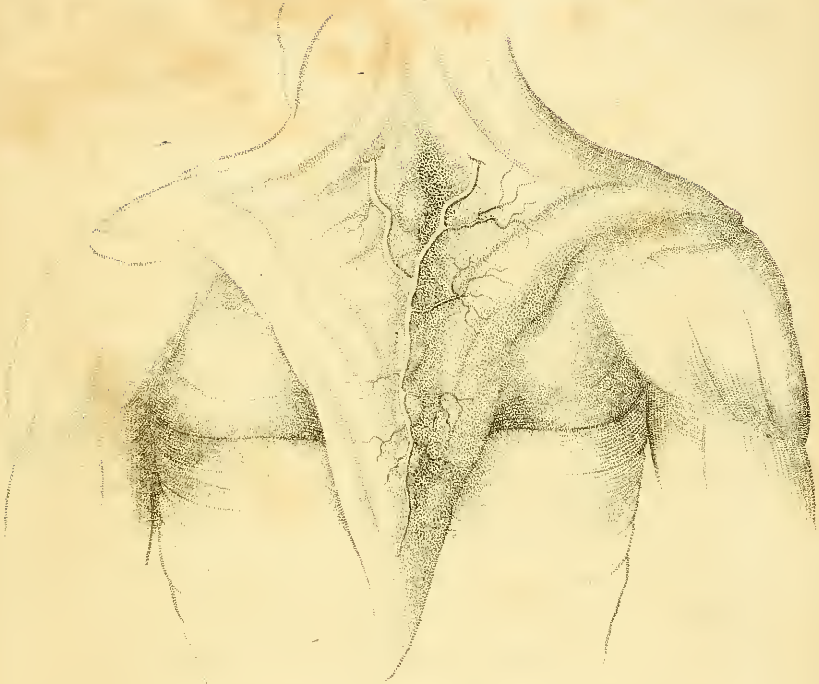
north, (rytina.) Carnivorous animals such as cats, dogs, the hyena and otter have a strictured circle or hymen separating the vulva, from the vagina proper. The female bear and coati present a divided membrane,—in the daman, (hyrax capensis) it is a circular fold. The ruminants and solipeds, (such as mares and asses) previous to engendering have an analogous membrane. Among the apes and monkeys, the hymen consists of two crossing membranes placed on each side of the canal of the vagina, their extremities being supported on a longitudinal roll which extends through the upper and lower part of the vagina. The same circumstance is remarked in the American apes as in the coaïtis, marikinas, wistitis and other sagouins." [*Nouveau Dictionnaire d'histoire Naturelle.* p. 515.

SECTION X.

VENA AZYGOS DORSALIS.

In plate 7, is given a very correct representation of a vein not figured nor described in any book of Anatomy to which I have had access, and for which I have proposed the name of azygos dorsalis from its peculiar character.

This vein lies immediately under the integuments of the back, and emerges at a short distance above the origin of the trapesius muscle. It ascends external to the trepesius as a distinct trunk, receiving branches from both parts of the muscle until it has risen as high as between the third and fourth dorsal vertebræ. Then it separates into two trunks, which diverge an inch or more from the spine, and penetrate the muscle immediately above the second dorsal vertebra and empty their blood into the subclavians by means of the deep seated cervical veins. The ordinary veins of the back send their blood more directly to the heart by pouring it at once into the branches of the intercostals terminating in the vena azygos, *interna*.



J. Drayton Sc.

The drawing of this vein, made by Mr. ***W. B. Fahnestock,*** a member of the class gives a very accurate idea of the situation and character of this vessel.

SECTION XI.

Description of the Table invented for the Philadelphia Anatomical Rooms.

THIS beautiful and most excellent table was devised by Mr. COLEMAN SELLERS of Philadelphia, October 1823; after having seen how inadequate the common table was for showing with any advantage to the class, almost all the necessary views in anatomy. Anatomical tables have hitherto been made so as to turn on a pivot, to allow the subject to be presented to every part of the room. When it is necessary to elevate the whole or a part of the subject on the common table, blocks of wood are employed, and if it be required to change the position during the time of lecturing it cannot be done without much inconvenience.

Mr. Sellers' Anatomical table is six feet in length and is supported on one strong column of wood about six inches in diameter. This upright is bored to receive the strong iron pivot more than two feet long which is fixed to the floor by strong screws. The top of the table is formed of four

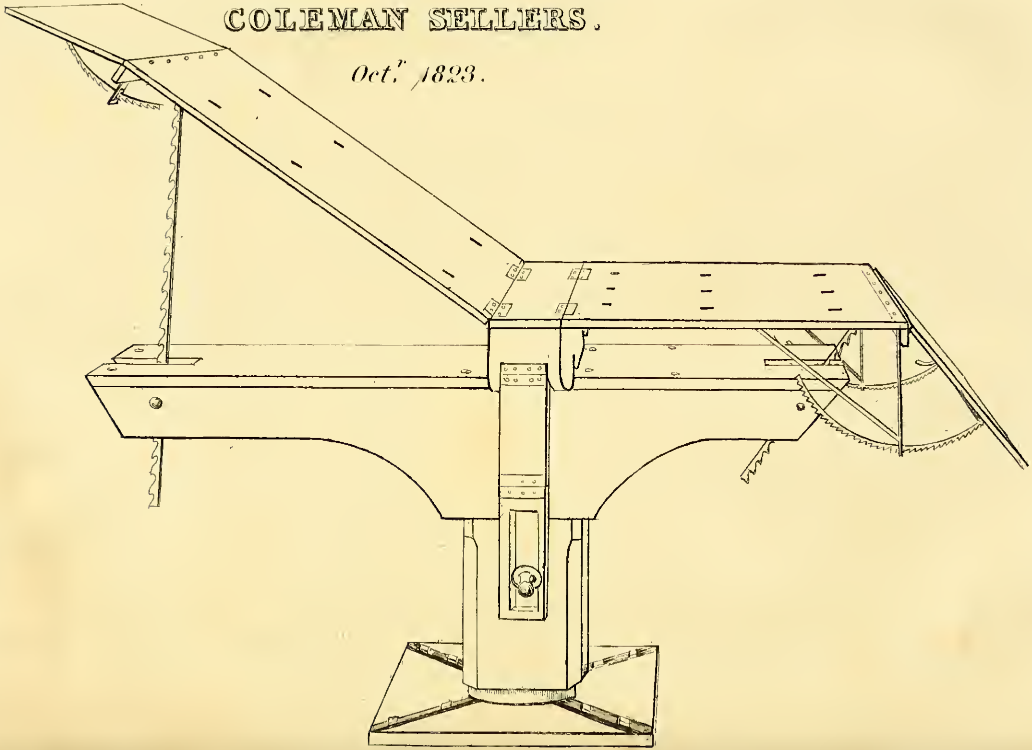
INVENTED for the PHILADELPHIA

ANATOMICAL ROOMS,

by

COLEMAN SELLERS.

Oct.r 1823.



parts, jointed in such a manner as to allow their positions to be readily changed. In the centre both sides are hinged to a strong transverse piece of timber, and at six inches from one end, and at eighteen inches from the extremity at the opposite end, there is a hinge which allows these portions to be raised to a level with the general surface of the table or to be depressed to any degree in the quadrant of the circle described by folding it down to the extent permitted by the hinge. The larger and smaller divisions are sustained on strong and easily managed iron racks, which keep the part raised in whatever portion it may be left. The smaller racks at the extremities are governed by a thumb piece, which when slightly touched throws the rack off its rest and allows the leaf to descend. To raise the greater racks bearing the larger parts of the table it is only necessary to push them slightly with the foot, by which stooping is rendered unnecessary.

Besides the general and partial elevation, and depression of the extremities, this table may be elevated or depressed laterally to any useful degree. This is effected by a broad and strong joint formed in the lower part of the transverse piece of timber to which the extremities of the table are hinged. The table is kept at any degree of lateral elevation or depression by a very beautiful and simple mechanism. A small piece of mahogany is hinged to the side of the table, and at the angle it forms with the supporting column, the lower part being mortised to the proper distance to allow this piece to traverse on a wood screw by which it is firmly held at whatever degree of elevation or depression is required. Both extremities of the table are perforated in various places by small parallel mortises through which straps with buckles are passed, for the purpose of keeping the subject in its place whenever the position of the table is changed.

The great superiority of this table over every other consists in the facility with which the subject may be moved in various directions, so as to give the class better views not only of different parts, but various views of the same parts; and doing away the necessity of the clumsy blocks commonly used, and the unpleasantness of calling in assistants to drag the subject into a different position. Another very decided advantage, is, that we can with this table exhibit almost every part of the body in its natural situation. Thus, we do not show the muscles destined to move the arm and trunk with the subject stretched horizontally, but sitting up in an unconstrained position. By this the student is saved the trouble of reversing every thing demonstrated, in his mind, in order to get some idea of its *natural* relations. By depressing both extremities to the utmost, and having the subject placed directly over the centre, we can with this table give views of the abdomen, thorax and pelvis, altogether impossible with the ordinary table. In demonstrating the brain or other parts about the head, we cannot with blocks do more than raise the head in a very unsteady manner to a certain degree, with this table it may be raised at pleasure, so as not only in an instant to be depressed, but depressed to the slightest degree, moving the fourth of an inch at each time to accommodate the head to the immediate section made.

When we are demonstrating the organs of sense, or other parts, where we do not use the whole subject, then by elevating both leaves of the table to a certain degree, and depressing the extremities until they are brought level, we are thus furnished with two very convenient stands at the ends of the table, for our specimens or preparations, while the basin, sponge, towel, &c. may be placed in the centre. This arrangement is the more excellent as it brings the specimens nearer to the eye of the student, and saves the teacher from the fatigue and unpleasantness of stooping.

The strength of this table is very great and far beyond any weight to which it is to be subjected. The motions are so easy and the positions may be varied with so much facility, that they sometimes are changed ten or twelve times during a single lecture, to accommodate to particular parts of the class. The circular motion is so easy, that with a large subject on the table, the slightest touch is sufficient to carry it round the circle. A full view of the table is given in the accompanying plate.

The following sketches will give a good idea of some of the various positions that this table may be placed in. Their uses will be readily understood by any one acquainted with the objects a teacher of anatomy has in view.

[Mr. John James, Jr. No. 24 N. 5th Street, who made this, has the model and can furnish similar tables at a short notice.]

A TREATISE

ON THE

MINUTE ANATOMY

OF THE

BONES,

TRANSLATED FROM THE LATIN

OF

ANTONIO SCARPA, M. D.

Professor of Anatomy in the University of Pavia;

BY JOHN D GODMAN, M. D.

LECTURER ON ANATOMY AND PHYSIOLOGY,
PHILADELPHIA.

A TREATISE

ON THE

MINUTE ANATOMY

OF THE BONES.

ALTHOUGH the osseous system has for a long time been carefully studied, and every thing peculiar to it is thought to be well known—though we possess both learned and laboured treatises on the human bones, with most beautiful engravings, delineating them as is said, "to the life"—and though there are many anatomical teachers, who (on account of the immense quantity of minutæ gradually accumulated) hang over them during whole months, exhibiting to their auditors all their inequalities, and pursuing every individual depression and spiracle to its termination—nevertheless, without sneering or arrogance, it may be stated that an addition may be advantageously made to our knowledge of their minute anatomy. Relinquishing and rejecting the hypothesis published by Gagliardi, concerning the *corrugated lamina,* and the quadruple order of hooks joining these lamina together, as well as what *Havers* has written relative to the spiracles conveying an oily fluid into the bones, we shall find that the more recent doctrines relative to their minute anatomy, are neither more correct, nor more useful. Teachers say, as with one voice, announcing it as a thing thoroughly investigated and clearly established, that the bones are composed of *fibres, layers,* or *tables,* placed upon, or so connected and joined with each other, as to have their strata intermingled. They say, moreover, that the fibres are stretched out in cylindrical bones according to their length, but in flat bones are disposed from the centre to the periphery, and lastly, that the strength of the bones depends on the size, number, and length of the layers. Those who attempt to support this doctrine, seem to have very slightly studied the nature and truth of the fact, when they produce calcined* bones, which split into leaves and tables, and add the testimony of surgeons who

* In my experiments to test the accuracy of Scarpa's observations, I found that the *apparent* lamination of bone was never produced, except when the surface was suddenly and unequally heated. Bones calcined with a slow and steady fire, never gave me the least appearance of *tables.*

J. D. G.

daily see caries removing layers and plates from the sound bone—thus yielding their belief to deceptive appearances, instead of making anatomical researches.

An attentive examination of the minute structure of the internal surface of young, as well as of the harder part of adult bones, will convince any one from the first step that the former doctrines have been too hastily advanced and too rashly adopted. A careful observer would find, that the whole of what is called *fibre* in bone, is a mere mistake, and the short lines to which name of *fibre* is incorrectly given, occupy a very small space, and join at different angles with other very short tracts of the same kind, and by their successive apposition, easily impose on the careless observer, as if they were filaments continued throughout the substance of the bone. By the use of good microscopes, every one will readily perceive that these tracts are *branched**—unite with the nearest portions at angles of different degrees of acuteness, and being interwoven in a multiplex way, constitute a *reticular*

* Malpighi formerly observed the same thing, *Anat. Plantar.* "These filaments are not all parallel to each other, and hence short appendices are given off, without being bound together, form a *net*, differing very little from the nature of *bark*, the area of which being larger, and the whole compages of fibres expanding, swells with an osseous juice.

structure, which may be plainly seen throughout the whole superficies of a bone, whether it be flat or cylindrical.

In relation to the layers and tables stratified in bones, every proper observer will understand and confess, that *calcination* is too rude a process, to to give anatomists any right to conclude that bones naturally are formed of many strata, or by the coalescence of superimposed layers. Although these are the hardest organs of animals, yet they are not throughout the whole of their peculiar structure of the same density, and held together at all points by an equally cohesive force ; when acted on by heat, they must necessarily separate unequally and split in strata, although this is very far from being the natural structure of the bone. Because during life caries separates plates from the bone, it is not therefore fair for anatomists to assert, that the bones are naturally formed by superimposed tables—since sometimes the softest parts of the human body, and particularly the skin, is removed in gangrenous crusts and layers, from the supposed sound parts, while there is nothing better ascertained in the whole human structure, than that the substance and texture of the skin differs as much as possible from lamination.

Not only is the outer surface of the bone, which may be easily seen by any one, of this character, but I pronounce and affirm that even the greatest part of the whole osseous system is *reticular* or *cellulous*. To demonstrate this I do not impose a very severe task on myself. It will be sufficient to show all the bones split, as Cheselden did, and I was accustomed to do during many years, before my class. By this simple method of treating the whole skeleton, it is made evident at a glance even to the most inexperienced, that the largest portion of the bones is cellulous or reticular—the residue being a hard concrete and stony substance which surrounds the reticular structure like a bark. The quantity of this cortical matter in proportion to the spongy part is very small in the scapula and ilia, and is still smaller in the bodies of the vertebræ, when a large mass of spongy substance is but slightly covered by a thin bony crust. The lower jaw clavicle, and especially the sternum and ribs are in great part spongy. The bones of the carpus, metacarpus, tarsus and metatarsus, and joints of the finger and toes, have a quantity of spongy, loose, and cellular texture, so far exceeding their external crust, that the bones of the hand and feet may without impropriety be termed *spongy*. In relation to the rest of the joints, it is very commonly known, that the middle of the cylindrical bones, as the arm and thigh bones, the radius, ulna, tibia, and fibula, are very hard and firm, but as we gradually approach their extremities, the texture becomes looser, and they swell out in light and spongy protuberances covered by a thin external osseous sheet. Not only do we observe this in all the bones of the skeleton, but in the cartilages, as those of the ribs and of the larynx, which sometimes, though rarely do ossify. When these are split through the middle, there will be perceived nearly the same proportion as in the true bones, between their external compact crust and their reticulated alveolar substance.

The whole controversy, therefore, relative to the minute anatomy of the bones, as far as I can judge, returns to this—not whether the structure of the greatest part of the bones is generally cellular or not, (as this is sufficiently proved by the sections made with the saw before-mentioned,) but whether the hard and almost rocky walls of the bones, and their compact external crust no less than their internal substance, partake of this cellular texture. That I may answer this question as satisfactorily as possible, I have thought it best first to investigate the subject synthetically, and then analytically. Hence I began by examining the bones in the first rudiments of animation, that is, when the cartilage first changes, and the earliest traces of the future bone begin to appear at the same time. Then I deprived the hardest bones of an adult of their earthy particles, and reduced them to their original softness and pellucidness, thinking, as was proved by the experiment, that however entire the maturity of these bones might be, their minute structure would exhibit the same order and relation as was seen in the embryos. I therefore repeated Haller's experiments on the formation of bone, in the incubated egg, the chief of which I subjoin entire, as they are recorded in my notes.

Eighth Day of Incubation.

The femur and tibia were properly formed, but entirely cartilaginous, flexible, pellucid, in which no dissimilar point could be observed with the most powerful glasses. When dried they had the appearance of desiccated gum.

Ninth Day.

A yellowness begins to appear about the middle of the femur and tibia. The cartilage in that *place* begins to be somewhat *wrinkled* and *crisped,* but the rest light and pellucid.

Tenth Day.

The femur and tibia much more yellow and wrinkled in the middle than yesterday. *These* *wrinkles* magnified by a good microscope, exhibited a very beautiful *network,* the lines mutually concurring at acute angles—yet this *network* was still cartilaginous and flexible, differing in nothing from the rest of the cartilage of the future bone, except in opacity, yellowness, and a slight degree of roughness.

Eleventh Day.

In the middle of the femur and tibia the roughness, or network, begins to harden. Being dried both sustain themselves by the middle, while the rest of the cartilage of the tibia and fibula collapses and appears like a gummy substance. The middle portion, which is not destroyed by drying, is a bony, rough reticulated crust, which is only a little thicker in the middle than at the extremities. Moreover, near the lower part of the tibia and fibula, *red spots* begin to appear, which show the situation of the inferior *nutritious artery.*

Twelfth Day.

About the middle of the tibia, the *network,* or original ossification, is terminated by two red points, one above and the other below. The superior *nutritious* artery begins to be visible. The bone when dried, preserves its cylindric form in the middle.

Fourteenth Day.

The opake, reticular, and anteriorly osseous middle of the femur and tibia, is perceptibly extended towards the extremities, and terminates in both directions in *zones*, very full of red blood, surrounding both ends. These very delicate beginnings of ossification are very plainly discoverable by microscopes of ordinary power, and show that the structure of the bone is by no means *fibrous*, but altogether *reticular*, cellulous, and flocculent, and is manifestly formed from very short lines or tracts running together at acute angles.

Fifteenth Day.

The whitish, reticulated osseous substance is much more extended towards the epiphyses. The zones of blood-vessels situate at the extremities of the ossification, were broader and exhibited a more vivid redness. The reticulated osseous structure was very conspicuous to the naked eye. Splitting the femur and tibia in their length, the internal part of the bony tube was formed of reticulated matter—the walls of the tube throughout their whole length were downy or flocculent, having no vestige of tables or lamina arranged over one another. But the blood-vessels which went from the zones, from the beginning, both in giving and receiving the little twigs, follow precisely the same order, and exhibit the reticular structure.

Sixteenth Day.

The reticular osseous structure of the femur and tibia reaches nearly to the epiphyses—even on the cartilage which tips the extremity of the bone, a rough surface is visible, which is the rudiment of the future bone—and nothing is wanting to change this roughness into real bone, but the deposition of earthy particles. The redness of the zones is greater than on the fifteenth: from either extremity of the bone, towards the middle it is increased and expanded, so that the whole bone seems suffused, as with a sanguineous dew. The femur being split through its length, gave no indication in any part of the bony tube of a lamellated structure, but every where appeared flocculent, reticulated and cellular.

Eighteenth Day.

The reticulated osseous crust occupies the whole of both bones, except a small part of the cartilage on the extremities of the tibia and fibula. The superior and inferior vascular zones are very much expanded, and nearly meeting and intermixing with each other in the centre, tinge the whole femur and tibia with redness. Both bones being split in their length, their walls throughout appear alveolar and cellular, and also stronger than in the sinuosity of the femur of the opposite side. The tube of both bones was here and there interrupted and confined by cartilaginous partitions. The internal periosteum, exhibited the appearance of many blood-vessels collected together, and was intensely red. But near the epiphyses, the cartilage which remained of the diaphysis of the whole bone, was elongated in the form of a cone in the medullary tube, or bony pipe, which cone gradually terminated in a point near the middle of the bone. Through this cartilaginous cone on the extremities of the bones, some vessels passing from both *zones,* reach to the epiphyses with a bifurcated termination. The frontal bones were still very flexible, and almost cartilaginous, yet were in no point fibrous, being in all parts manifestly *reticulated.*

Twenty-first Day.—A chicken near being hatched.

The femur and tibia were not so red externally, as on the former days. In the middle of both bones the reticular structure was more close and compact than usual, and the lines appeared to run together at more acute angles than on the first days after incubation—hence it happens that those small tracts concurring at acute angles readily deceive superficial observers, as if they were fibres extended in the length of the bone. The femur and tibia being vertically divided, the internal periosteum presented, covered by an oily mucus, and he medullary tube was filled, by small cartilaginous tubercles. But in the extremities of the same bones, the cartilage which rose in the form of a cone through the bony tube, was changed to a pellucid sponge of cartilaginous elasticity, grooved by oblong depressions and sinuses. It necessarily follows, from the evolution of this conical cartilage, and from the separation of the same into pits and cells, that the proportion of these protuberances is very much increased at the diaphysis of the bones, on account of their greater amplitude and the swelling of this *conical cartilage*, which far exceeds the diameter of the bony tube.

A chicken two days before being hatched.

There was nothing of cartilage in the extremities of the femur and tibia, except the epiphyses. When the periosteum was removed, the blood-vessels appeared every where mixed and interwoven with the bony net-work. Both bones being divided as usual, the internal periosteum was very red, and the vessels of the marrow, bedewed with much oily mucus, were extended from the extremities toward the centre of the bone. In the middle of the femur and tibia, where, from the commencement of the ossification, the whole external surface of the bony tube was downy and flocculent was now seen a hardened covering, manifestly drawn and crowded together in tracts and areolæ of reticular structure. The *cartilaginous cone* which I saw on the former days in both extremities of the bone, drawn out into depressions and little circles, and very tumid, I find has become a fragile, bony sponge, forming the protuberance of the bones. Moreover, I again see red vessels pass from both extremities of the bone to the epiphyses, to form the ossification of their cartilaginons appendages in the usual way.

Thus far the observations were made on the incubated egg, and the original structure of bone in human embryons when about twenty-eight lines long. For in these, as in the chick about the fourteenth day of incubation, the middle of the femur and tibia, which scarcely equalled two-thirds of the whole length of the bone, was osseous—the remainder was cartilaginous. The external surface of both bones stripped of the periosteum, and examined with the best glasses, appeared beautifully reticular, very short branching lines running together at acute angles, altogether resembling the first evolutions of the bones in the incubated egg. The embryon bone split through the middle, exhibited the downy and flocculent substance both internally and externally. Although the frontal and occipital bones were so pellucid and flexible that they appeared entirely cartilaginous, yet the minute structure was manifestly reticular—both the whole of the scapulæ and ilia were spongy, being still unprovided with any harder external covering.

The conclusions which are to be drawn from these observations, unless I am very much deceived, are the following:

1. That the cartilages were the models of the future bone, and all the parts of the bone visible, existed in the form of cartilage.

2. The reticular or cellulous bony structure which first began to appear about the middle of the cylindrical bones, was always immediately preceded by a wrinkling of this part.

3. That the cartilaginous model is changed to bone by the action of the sanguiferous vessels and

the addition of earthy matter, in the rugose cartilaginous tracts, by which means the osseous net-work is made.

4. In the incipient state of ossification, the whole height and thickness of the bony pipe of the cylindrical bones, both without and within, is light, downy and cotton like, having no trace of hard covering externally.

5. When the ossification is perfected, the walls of the cylindricial bones receive an increase of density about the middle of the bone, with a diminution of breadth, as the *reticular texture* is more closely drawn together than before, and compacted in the tracts and alveoli. What forms the external crust or cortex of the bone, is nothing more than the light, reticulated cellulous structure brought into a hard body near the surface of the bone; and this, both in the cylindrical and flat bones, does not appear about their middle or centre, before the entire ossification of the cartilaginous model.

6. The sponginess, which is greatest in the extremities of long bones, is by no means derived, as many anatomists teach, from those lamina, or tables, which pass from the walls of the bony tube and go into the medullary cavity, but it is to be referred to the primordial cartilage, which at first stretches the *cones* upwards through the medullary

cavity, and at length the areolæ and cancelli being removed, expands more fully, and swells very much like tuberous sponge in the extremities of the long bones.

7. Finally, the original more minute texture of the cylindrical and flat bones, both in the incubated egg and the very early human fœtus, (when indeed both the bones, scarcely begun, are still flexible and light,) are nothing but a slightly reticulated or cellular substance—and moreover, if sometimes distinct little spots, remote from the centre of ossification, occur in the progress of ossification, they are at length consolidated and peculiarly interwoven with the portions next them, the whole bone being thus formed of retiform structure.

In the next place, since we find this to be the fact in the first evolution of bone, let us consider the more minute structure of the bones in detal—especially the nature of the *corticil* substance of the bone, which is most manifestly made up from the compacted osseous net-work. This, which has been detected by the synthetic method, I felt sure of confirming by analysis, as the hard external of bones could be wholly cleared of their earthy particles, and then might be gradually loosened, until their peculiar structure could be fairly shown.

Therefore I kept the tibia of an adult, in dilute muriatic acid sufficiently long to extract the earthy particles—by this process, common to anatomists, the very hardest bones are converted into a cartilaginous substance of great flexibility and translucency, without in the slightest degree changing their natural forms. When I had reduced these bones to this state, I mascerated the cartilaginous residue in pure water, in the same manner as is done when we wish to reduce membranes, viscera, skin, tendons, or aponeuroses to cellular substance. By a long continued experience, I have at length learned to reduce the external covering of the tibia of an adult to a downy reticular texture, similar to that which is found in the extremities of the bone, except that the close and much compressed texture of the cortex, appears loose and dissolved, in the meditullium and tuberosity of the same tibia. In fact when the parenchyma of the tibia was cut perpendicularly, no vestige was found either externally or internally of fibres, not the slightest indication of lamination, or plates, in the thickness of the bony tube—but the whole of the hardest crust of the tibia throughout its extent, appeared to be formed of *cellulous* structure, so disposed in cancelli and tracts of net-work, that what belonged to the superficies of the tibia was much compressed and gathered on itself. The cancelli gradually relaxed, and enlarged more and more, until they were swelled out to that sponginess found in the medullary cavity and extremities of the bone.*

I have with much pleasure observed that the compact substance of the tibia now under consideration, is of a cellulous reticular structure, when this cortex has been deprived of its earth and moisture, and afterwards placed in oil of turpentine. For on account of the high degree of pellucidness of a bone thus treated, the slight net-work of which it is ultimately composed, may be clearly seen—and the naked eye, can discover without error, that the very hard crust of bone is really of a cotton-like texture, and made up of very short branching tracts, variously joined and interwoven.

The same circumstances were manifested by a section of the very hardest portion taken from the middle of an adult tibia, suspended in spirits of wine after the earthy matter was removed, and carefully examined by reflected and refracted light. The soft cellulous texture was shown, in which small cones of the same soft substance of different

* I have repeated all Scarpa's experiments on adult bones, and have examined in the same manner the very hardest parts of the cylinder of the thigh bone. The results have been so uniformly similar to those above related, that it is not possible to avoid adopting the author's conclusions.

J. D. G.

figures adhering together, formed here and there larger and smaller areolæ, nearly like the soft cellular texture.

The *reticular* structure is not only to be seen in the cylindrical, but also in the compact tables of the flat bones in adults. Thus the internal and external crust of the frontal and occipital bones, being made flexible and pellucid, and suspended in oil of turpentine, the whole is found to be in every part *reticular*. So great is the resemblance of this crust to the structure of cellular texture, that it might readily be mistaken for a membrane reduced to a cellular web, by long continued maceration. However, I have remarked the form of the cells in in the crust of flattened bones, to be different from those peculiar to the net-work of cylindrical bones; that, for instance, the areolæ in flat bones are more oblong than in the cylindrical—as if the cellulous spaces and areolæ of the flat bones had been drawn in different directions, while the bones were yet soft and cartilaginous. Hence analytic examination of the cortex of hard adult bones, shows that there is almost the same disposition of principles in the construction of the hardest parts of their bones, as in the embryo at their first evolution; and the conversion of cartilage into bone—that all the bones, even the very hardest, are composed of a collection of small tracts, which extend through very short spaces, and unite at different angles, *forming a net work.* It is not from conjecture, therefore, but the force of positive observation, that we declare the opinion hitherto taught in anatomical schools, that bones are formed by tables, lamina, and filaments, is unfounded, and must be rejected as untrue—and we affirm, that all the bones, whatever be their figures, are in their minute structure *cellulous* and *reticular,* sometimes very close and compact, as in the cortex of very hard bone—at others, loose and free, as in the cavities and tuberous extremities of cylindrical bones. Those short tracts which anatomists have mistaken for bony fibres, can neither be followed in the length nor breadth of the bone, nor do they ever attain any notable length.

In fact, as often as I attentively examine the minute cellular texture under consideration, and observe that it is very close and compact at the surface, and grows gradually looser and looser as it approaches the internal part, and the spaces and cells become very much larger, and at length form the spongy structure of the meditullium, and extremities of the bones, I cannot avoid concluding that there is in this construction of the bones, a great resemblance with the texture of the true skin of animals. For this corium, which is beyond doubt of a cellular texture, where it covers the external surface, has its cells drawn together and closely compressed, is very firm and compact, but its internal surface, has its cellular structure more and more relaxed and enlarged, till at length by the introduction of air it is easily swollen, the and sub-cutaneous net-work is loosened and enlarged. Thus in bones I see a cellulous *net-work*, very close and firm on the outer surface of the bone forming a hard crust, and the same substance gradually becoming loose toward the centre of the bone, enlarging and swelling out to an osseous sponge.

Since then it is demonstrated, that the minute structure of the crust and meditullium of bone is entirely of the same cellular structure, it will not be difficult unless I am much mistaken, to understand why the cylindrical bones of very young fœtuses, which in the beginning throughout the whole extent of the walls of the long tube, are equally light and cotton-like, should with increase of age be externally covered by a hard and compact crust—also why it happens that the cortex of the bone is uniformly in inverse proportion to the meditullium, or what is more remarkable, why the cortex should be thick and very hard where the spongy substance is in smallest quantity—and on the contrary, the cortex is slightest where it covers the greatest quantity of spongy texture. From what I have advanced relative to the commencement of ossification in the incubated egg, and in the human fœtus, it appears, that perhaps, a greater quantity of osseous substance does not exist in the middle of cylindrical bones than in their extremities, that, such is the condition of the cartilaginous model of the future bone, that the portion of this cartilage belonging to the extremities, which hardens latest, is more extended and spread out over larger spaces, alveoli and depressions, than the middle portion of the cartilaginous model. Therefore, since the texture of the cortex and meditullium is entirely the same as before stated, *reticular* and *cellulous,* nature in her own way and at the proper place, as in the middle of the cylindrical bones, constringes and compacts it to form a hardened cortex—but in other parts, as in the tuberous extremities of bones, she loosens and spreads the same material like a sponge. In fact, no one should think this compaction and change of a lax cellular texture into a solid and hard body to be the only example occurring in the animal economy, and merely contrived and designed for giving strength to the bones, since nature employs exactly the same means in all animals, and in all organs composed in a great degree of soft cellular texture, for keeping them in their places, and giving them more solidity and strength. If this should appear doubtful, nature herself teaches, that the soft membranes of the embryon are changed and hardened into firm tunics, elastic ligaments, and tendons, articular capsules, and vascular coats. Those who have hitherto supposed the minute structure of bones to be formed in strata and tables, have been accustomed to support their notion by imagination, fancying that the middle of of every cylindrical bone, when it is hardest and firmest, is composed of numerous tables, and as we gradually recede from this tabulated centre towards the extremities, that they become diminished in length, and those that are turned towards the medullary cavity, become so inclined, that at length meeting together in the middle of the bone, they are in a multiplex manner admixed and interwoven with each other, and changed into the spongy substance of the meditullium and tubers. The whole of this hypothesis falls of itself, if the facts are properly weighed, which we have demonstrated relative to the minute primordial *cellulo-reticular* textures of bone. Moreover, even this tabular structure admitted, it would be impossible to understand how the same strata of bone could be driven, as *Haller* thinks by the dilatation of the arteries, from the superficies of the bone towards its medullary tube, till at length by their meeting, the form and condition of a spongy mass is produced.

But although the natural course and order of ossification is, that the *cellulo-reticular* substance which is placed in the middle of the bones, should change with the maturation of the animal, gradually contracting its cells, and hardening the little portions of cellular texture—and while solidifying, the cellulo-reticular structure of the extremities and tuberosities, should at the same time extend the cancelli, and enlarge the net-work, so as to increase the whole size of the bone—nevertheless, observations furnished by pathology are not wanting, to show that a faculty and aptitude exists in the very hardest cortex of adult bones, which enables them under certain circumstances, like the cellulous structure of the extremities, to swell and enlarge beyond their natural condition.

Although I had suspected that this remarkable power of nature in relaxing and enlarging the external covering of the hardest bones, was often resorted to by her in curing diseased bones, yet I never was so clearly and undeniably satisfied of it, as in the case of a puppy, whose leg I had freely broken. I opened the tibia of this dog, down to the miditullium, and by this opening, introduced a probe and destroyed the marrow of the bone, filling up the cavity with lint, not without much injury to the inner wall of the tube. On the following day the whole leg swelled violently. About the sixth day, a free discharge of pus ensuing, the tumefaction of the soft parts about the wound subsided—the tibia at the same time was found to be very tumid, and gradually to increase in size, until about the fortieth day, it had the appearance of a great exostosis. The dog was killed, and this tibia was examined by cutting through its length, when the whole of the cortex was found to be expanded to *cellulous* texture, and moreover, the walls of the tibia of this puppy that were scarce half a line in thickness, were now changed into a spongy substance, of more than six lines in thickness throughout the length of the bone.

Similar circumstances are frequently found in the human race, as when any cause injures the meditullium of bones leaving the corticil part untouched, or when the nutrition and increment of the bone from the internal texture is injuriously hindered by the presence of some foreign body. For in either case nature provides for the preservation of the continuity and strength of the diseased bones, relaxes with great effort their compact external surface, which enlarging to a spongy consistence, and being prolonged internally, compensates for the loss of the meditullium—or swelling outwards increases the height and breadth of the bony tube—or, at length by surrounding the injured bone with the sponginess from the cortex, receives and contains it in a sort of sheath. This spongy sheath in the beginning is light, flexible, and cotton-like, but gradually hardening by the acquisition of earthy matter, it comes at last to perform the office of the sound bone—the primitive bone wastes away, and at length loses its continuity with the osseous case.

We may reasonably demand of those who teach that the hard walls of bones are made from many plates or tables superimposed, how they can reconcile such facts with their hypothesis. For it is certain and manifest under the circumstances mentioned, that the bones neither separate into layers, nor, properly speaking, does nature generate a new bone to replace the miditullium, or to include the injured internal wall in the bony sheath, but only allows the compact and much compressed texture of the outer part of the bone to become freely enlarged and expanded.

But while engaged in writing this essay, I have before me another most excellent example of this change and transition of the compact substance of the bone into a cellular mass, furnished by the bones of children, in whom the hardest parts of the bone, and especially of the joints, are reduced by disease to the softness of wax, and become almost pellucid. In consequence of this disease, the bones being deprived of their earthy particles, or the necessary deposit of earth withheld, grow at last so soft and pellucid, as to be easily cut with a knife, exactly like those bones which have long been macerated in diluted mineral acids. Diseased bones of this kind have their substance like cartilage, very light and flexible, and more delicate and spongy within than it is possible to describe. Having cut one of them through its length and suspended it in spirits of turpentine, it was translucent like jelly, exhibiting the minute structure throughout reticulated, and particularly evinced and confirmed the fact of the cellular nature of the external crust of bone.

While speaking of bones deprived of their earthy matter by disease, it presents a fair opportunity for observing what happens sufficiently often, that bones from some peculiar virus may become diseased, not throughout the whole body, as in general rachitis, with softening, but are deprived of their earth in a particular spot, and are affected by a local rachitis, making them soft within certain defined limits. Where this occurs, the cellular texture of the bone loses its character and rigidity as bone, at the point whence the earthy matter is removed, and assumes the flexibility and ductility of cartilage, becoming subject to distension and swelling, like the soft organs, such as membranes, tendons, ligaments, vessels, and other parts composed of cellular substance. Under such circumstances, if the softened bone is exposed by the want of an outlet to the action of acrimonious fluids, it swells, becomes violently distended and red, and soon forms an irregular fungous mass, similar to excrescences of diseased flesh.* The phenomena of spina ventosa and pædarthrocace, are well known to surgeons, the bones at first softening so slightly as by no means to allow of the introduction of a probe—at length becoming a sort of fleshy matter, the skin is burst up and presents a wretched spectacle—the tumour bleeds on the slightest touch, and pours out a fetid discharge. This change of the bone into a substance similar to flesh, and its easy distension, shows that there is much similitude between the cellular texture of the substance of the bone, and the common cellular texture, whose great ductility and the facility with which it forms fleshy tumours, is equally well known to physiologists and pathologists.

* In one case to which I was called, there was an enlargement of the tibia about two hand-breadth's below its head, with a large opening through wich an ill-looking fleshy mass could be seen within, and from this opening a very unpleasent discharge was kept up. The patient about fifteen years old, sufferred greatly, was extremely emaciated, and had regular hectic paroxysms. A probe could be passed in any direction through the diseased part of the tibia. When the foot was raised it was evident that both bones were fairly softened, and might be bent almost to any degree. Amputation was recommended—some delay was occasioned. The patient began to take bark freely for the debility, and in a very short time entirely recovered. J. D. G.

Sometimes it happens fortunately, that the bones swell to an extraordinary size, from the softening of their cellular structure, without injury to the animal. In fact, we think in opposition to the common opinion of surgeons, that this peculiar softening and germination, like fleshy substance from bones, is determined and promoted by a salutary effort of nature, to repel injuries done to the bone, or to restore the continuity when it has been broken. After fractures we see the points of broken bones first grow soft by the absorption of the earthy matter—afterwards from these points, already of a cartilaginous flexibility, we perceive a red substance to sprout forth, called by Celsus *caruncula*—and this caruncle extending according to the displacement of the broken bones, assuming various sizes and forms, connects the points together and fills up the vacancies caused by any loss of substance. In the living state this caruncle is red, but after death, being freed from blood and macerated, has the appearance and character of cartilaginous substance. In the living body this caruncle is well supplied with blood-vessels, which depositing earthy particles, gradually impart greater consistence, and proper osseous character, when the name of *callus* is bestowed on the mass by the surgeon.

In relation to the organic nature of *callus*, my own experiments, after those of DETLEF, HALLER, BONN and BOHMER, do not allow me to doubt. Those who have hithertofore taught that *callus* was something similar to gluten concreted with earthy matter, always appear to me to have very rude notions of the animal economy, and have not remarked that *callus* once formed in young animals, grows as it advances in age in the same proportion as the other bones, and is changed in colour by the use of madder, just as they are. The blood-vessels of *callus* may be minutely injected: and in short, callus when acted on by mineral acids, is deprived of earthy matter and resolved into a cartilaginous substance similar to the other undoubted bones. Such teachers, moreover, seem not to have observed, if it has happened before them, that when bones formerly joined and restored by *callus* are seized by rickets and softening, this *callus*, like the other bones of the animal, becomes softened and preternaturally tumid.

I have removed from the surface of the tibia in a full grown man soon after death, a portion of *callus* almost four inches long and one broad, still soft, altogether cartilaginous and easily cut with a knife—this specimen is preserved in spirits of wine. Its external surface has the appearance and form of the osseous crust—but the internal surface that adhered to the tibia, exhibited a most beautiful net-work, which at first sight could not be distinguished from common cellular substance. By examining this structure with a microscope of high power, it was plainly demonstrated to be cavernous, and altogether cellular, have many very minute earthy particles in it, especially in its external surface, which was firmer and more rigid than the opposite side.

It is wonderful to see the celerity with which the soft caruncle, filled with blood-vessels, shoots forth on the bones of birds that have been stripped of periosteum, first changing to cartilage, afterwards into a light downy bone, delicately reticular both externally and internally.

I have made the same experiments on the bones of kittens, which though not effected with the same celerity, yet terminated in a similar manner.

The tibia of a cat, from which a soft *callus* had grown after the periosteum had been removed from two-thirds of the whole circumference of the bone, was macerated in muriatic acid until the whole bone became pellucid and flexible. By placing this bone in oil of turpentine, I found that the *caruncle*, or rudiment of the future *callus* was continued from the cartilaginons model of the bone, and was nothiug more than a germination and intumescence of the cartilaginous substance of the tibia. I have seen the same thing plainly in the tibia of an adult man, who had suffered a vast laceration of the soft parts and periosteum, two months before death—the caruncle was sufficiently produced, and part of it had begun to change to bone. When the whole tibia was freed from earthy particles by the aid of mineral acid, and rendered pellucid, it appeared that the perfect *callus*, as well as the caruncle, formed one and the same substance with the whole parenchyma of the tibia—that is, the cartilaginous nucleus of the tibia was expanded into the *callus*, and was prolonged and stretched out uncommonly.

In another cat whose tibia was deprived of a long and broad portion of periosteum, a recently formed *callus* swelled out—when I had filled the arteries very minutely with red wax, this *callus* was handsomely tinged red, and the colour was distinct from that of the rest of the tibia. But when I had removed the earthy matter by acids from the whole tibia, and rendered it soft and pellucid, and examined it opposite to the light, I discovered an immense number of blood-vessels scattered through the *callus*.

Besides the proofs heretofore given, that the *callus* is formed by the intumescence, or germination, of the parenchymatous cellular texture of the bones, we may add, that whether we consider the formation of *callus* and the process of ossification, or look to the minute structure when the bone is perfected, we shall find all the circumstances of the original ossification and formation of *callus* are alike. The caruncle does not harden by the whole quantity of earth being deposited at once, but receives the earthy substance as in the formation of bone in the incubated egg, where the blood-vessels appear, carrying red blood, and supplying at the same time the necessary earthy particles. Since this condition of the vessels takes place unequally, as well in the cartilaginous model of bones as in the rudiment of future *callas*, it hence necessarily happens, that in both, small distinct spots appear at the commencement of ossification without any order, which finally unite together in the cartilaginous model of the embryon, or after fractures cover up and take place of the caruncle. As soon however as the caruncle is wholly ossified we find the *callus*, like the original ossification in the incubated egg, entirely cotton-like, reticular, spongy, and equally light and delicate throughout its whole extent. It appears as if forcibly compressed, and becomes more and more condensed until it hardens and is covered with an external crust or bark, which substance, as in the bones of embryons near the full time, increases more in length in proportion to the diminution of the cellulo-reticular structure.

The origin of *exostosis,* is undoubtedly similar to the formation of *callus.* For in such cases, the surface of the bone being, for ever so small a distance, deprived of the periosteum, becomes softened, is followed by a germination of the caruncle from this spot, which is lengthened and increased from the fluids circulating in it—hardens finally by the deposition of earthy matter, and produces a tumour whose minute structure does not differ, in the slightest degree, from that peculiar to the bones, if we except this circumstance, that the tumour is sometimes harder than the bone itself, in consequence of the greater quantity of earthy matter it has received. I speak now of the true and legitimate exostosis, which may have been originally caused by some virus—and although this has, by treatment or spontaneously, been removed, still the exostosis does not cease, because the caruncle shooting from the surface of the softened bone, obtains the nutritious gluten along with the earth from the common cement, and assumes the osseous character. A few years since I had occasion to remove the tibia and fibula near the knee, where a great exostosis swelled out, in a man of about forty years. I amputated the leg at the usual distance from the patella, through the exostosis. The wound in a short time was healed without being affected by the *exostosis*—the cut bones adhering to the integuments were covered by a firm cicatrix.

Caries is separated from the sound bone almost always in the same way that *callus* is formed. At the extremities of a bone suffering under caries, the earth is absorbed by the action of the proper vessels, and from this spot the caruncle shoots forth, which being treated with bland and emollient applications, separates the carious bone in every direction, and throws it off from the sound. When this happens, the caruncle which, as we have demonstrated, is very vascular, before it wholly ossifies, forms anastomoses with the surrounding soft parts, and even with the skin itself. On this account, after the cure has been entirely effected, we find about this caruncle, that the integuments are attached to the subjacent bone, and that there is a dense concave cicatrix formed thereby.

Therefore, in addition to the anatomical researches and observations made relative to the formation of fœtal bones, and their structure in adult animals, various morbid affections, the chief of which I have mentioned above, show that the minute structure of the hardest of these organs differs very slightly from the structure and properties of cellular texture, if we except that the common cellular substance is very soft and juicy, and the cellular texture of bones in consequence of the earth it receives, begins early to harden and has its strength and density increased by the daily addition of earthy matter. It is nevertheless equally certain, where the cellular texture of the bone is first deprived of its earthy particles, it becomes flexible and ductile, like many other parts of animals which are called soft and distensible, having as great an aptitude to swell or enlarge as the common cellular substance. As sometimes it happens in ulcers which are treated by an unskilful surgeon, by oily and relaxing remedies longer than is proper, the cellulous subcutaneous texture swells and rises above the skin like a fungus tumour, so it naturally occurs when the cellular texture of bone is deprived of its earthy matter, the same vital action forms and germinates the caruncle, which sometimes only unites the points of a broken bone, and at others, wonderfully replaces the material that has been lost. The celebrated Haller formerly taught, that the cellular texture was the great foundation of the animal structure, because all the membranes without exception, the vessels which are hollow membranes, the greatest part of the viscera, tendons, aponeuroses, ligaments and integuments of the whole body, are made of this cellular texture. This is not only true, but an addition of the bones may be made to this catalogue, on the authority of the most careful observations.

I have taken care to examine the minute anatomy of the bones in other animals, as in amphibia, reptiles, and fishes. In the great whale called balæna mysticetes, the cellulo-reticular structure is most fully evident, both in the bones of the head and shoulder blades, and in the cortex of the lower jaw, and the longest of the ribs. There is no great acuteness of sight requisite to detect the same structure in the bones of the delphinus phocæna, because the reticular structure in this animal is more visible, since there is but a small quantity of earthy matter concealed in it. The same structure is very manifest in the bones of the sea turtle, and in reptiles of every kind. In cartilaginous fishes, as the shark, frog-fish, sting-ray, and others of the same kind, whose bones contain even less earth than those of the dolphin, the reticular texture of the cortex is also far more conspicuous. In the scaly fishes, as in the pike, although the bones are very hard and contain much earth, yet the cellulous texture is very perceptible, and the branching tracts concur at acute angles, wonderfully and beautifully reticulated.

The salutary changes which we have mentioned heretofore as occurring in the bones, being effected and continued by the vital power and action of the vessels, it follows, evidently, that the bones, besides the great quantity of lymphatic vessels, are also possessed of a vast number of blood-vessels, and are really more *vascular* than any one not accustomed to minute anatomy can have any idea of. The celebrated ALBINUS, indeed, taught a long time since, that a vast number of vessels passed from the periosteum into the cortex, through the numerous spiracles of HAVERS, and these vessels, with others of the same character running through the meditullium, properly called nutritious arteries, anastomosed, and passing by particular openings through certain parts of the bony crust, enter the medullary cavity, bestowing the most minute ramifications on the marrow and its membranes. But ALBINUS, when he wrote this, thought that the blood-vessels immediately after entering the pores of the cortex, went in right lines between the strata of plates and tables. This I certainly know to be far from the truth, and foreign to the structure of the bones and the real distribution of the blood-vessels. When I had filled the vessels of the bone in a young and immature fœtus with most minute injection, I found the vessels of the periosteum immediately on entering the pores of HAVERS, not going off in right lines, but giving and receiving frequent branches, *encircling the reticulated structure of the cortex,* and joining each other at the shortest intervals, following the course of the osseous net-work. Where the cortex of the bone internally began to loosen to the spongy substance of the meditullium, the blood-vessels of the cortex also inclined to the centre, and their trunks joined at certain places, with those going to the marrow, as before stated. This seems to be a wise provision of nature, that at the same time the external crust of the bone is supplied with a large quantity of blood, a full and manifold communication should exist by these almost innumerable anastomoses, between the external and internal structure. I pointed out the mode of distribution of the blood-vessels in bones, as shown by injections, in the incubated egg of the sixteenth day, when the *red zones* which surround both the extremities of the tibia, being broadly expanded, meet in the centre of the bone. Under these circumstances, even should the external periosteum be removed, the cortex of these delicate bones is suffused with so great a redness by the abundance of vessels, that it seems to be covered with a sort of sanguineous dew.

Since the bones enjoy vitality, are nourished and grow like other parts, it is in perfect agreement with analogy to believe, that besides the great number of blood-vessels, they are supplied with nerves, although these can scarcely be demonstrated, not only on account of ther tenuity, but perhaps—because, as in many other parts, the very small nerves enter the foramina of bones in coalescence with the arteries. But if pathological observations may be allowed any weight, I may state, that I have more than once produced a sense of pain by scraping and abrading living bone. I have also observed that the *caruncle* which shoots from the substance of bones is endowed with sensibility, and have lately had a most excellent opportunity of confirming this statement. On a part of the tibia of a man, five inches long and one broad, that had been removed by the natural process—I wet the caruncle with camphorated spirits of wine, of which the patient, who was by no means timid, complained much—shortly after, I wet the point of a soft pencil with spirits of sal ammoniac, and when it was applied to the caruncle, the patient cried out. Now that the caruncle, which is nothing but the bone itself deprived of earthy matter, is entirely insensible and destitute of nerves, it is altogether absurd to assert.

The following questions may be asked relative to the minute anatomy of the bones. Is the *diploe* present in the cranial bones of the fœtus or not? Are the pituitary sinuses altogether wanting in the bones of the fœtus at full time? that is, are the *frontal*, *æthmoidal*, *maxillary*, and *sphenoidal* sinuses present? relative to which anatomists are yet undecided.

In relation to the first question, if any one attententively examines a perpendicular section of the cranial bones in an immature fœtus, with the aid of a good glass he will find a very singular and remarkable circumstance. The *reticulated cellulous* texture of the fœtal cranium on the inside is already solid, smooth and compact, and has already formed that table which is called *vitreous*—but the external surface of the cranium still remains light, reticular and flocculent, as it were surrounded by an osseous down. After birth, and especially in childhood, this reticular down is in greater quantity, the cancelli and areolæ are more and more drawn together, and solidified into a thin crust under the pericranium. This crust, moreover, envelopes the whole reticular substance of the cranium, and whatever remains after the formation of the two tables is confined between them and receives the name of *diploe*. If the ossification advanced beyond the middle, the portion of the reticulo-cellular substance between the two tables would be added to either the external or internal, and then the adult cranial bones would be entirely without *diploe*, but would constantly acquire a hardness and thickness beyond what is common. Wherefore, so far is it from fact that the *diploe* is wanting in the fœtus, that it should rather be stated that all the external surface immediately under the pericranium is nothing but *diploe.*

In relation to the pituitary sinuses of the nose, among the dissectors who affirm these cavities to be entirely wanting in the fœtus at nine months, (for many anatomists are of this belief,) some teach that these receptacles in adults are to be attributed to the action of absorbent vessels. For, say they, the material is absorbed from the middle of the frontal, sphenoid and maxillary bones, and is replaced at the margin forming new and large cavities. I freely confess that there is much excellent testimony to prove the great power which the absorbent vessels possess in removing both fluids and solids. Nevertheless, granting all this power to the absorbents, I do not understand why they do not equally remove the whole substance of the bone, as well as make local excavations at certain points. But passing over these disquisitions and doubts, we cannot withhold our admiration at some of the recent writers on osteology, who deliver it as thoroughly investigated and certainly established, that these sinuses are wanting in the fœtus at birth*—not re-

* What would Scarpa think of the positive assertions made very recently, and worst of all, *republished* in *Philadelphia*, that the frontal sinuses do not exist in every individual—and that "a gen-

collecting that the celebrated Albinus has described many of these sinuses in the fœtus of nine months, and illustrated them by plates. In fact I have before me, in a fœtus of this age, the *œthmoid* cells as delineated by Albinus, and also the *maxillary* and *spheno-basilar* sinuses proportionably as distinct as in the adult. The spheno-basilar sinus, at this tender age, is not only begun, but it is already fairly divided into two parts by an interseptum. The frontal sinus is the only one whose rudiments are obscure in the fœtus of nine months, yet it is not entirely wanting—but at that age the frontal sinus is not sufficiently distinct from the æthmoid cells, as is shown by the flatness above the nose in the fœtus, and the formation of a continued series between the frontal sinus and æthmoid cells in the adult.

The pituitary sinuses of the nose, like many other parts which are delineated in the embryon, are only evolved with the increment of the whole body. For the purpose of effecting this, in addition to the remarkable powers through whose action the nutrition and increase of the animal organs are

tleman of the medical profession, who had *finished* his studies at *Edinburgh*," dissected carefully at *Paris* for "*seventeen months*," and could not find the FRONTAL SINUS, except in a single instance, and that in the head of a "mad woman!!" See Combe's Essays on Phrenology, p. 83 passim. J. D. G.

kept up, I think that faculty of the animal economy by which the primordial, light, reticular, and cellular texture, at certain places and different periods of time becomes more condensed, or relaxed and spongy, as may be necessary, does much in the increment and evolution of the pituitary sinuses. Indeed, in the first instance, it follows from mechanical necessity, that the cavity surrounded by the osseous sponge, which is contracted and changed into a hard thin crust, should be increased. This is certainly manifest in the cylindrical bones, which are spongy and cotton-like throughout their whole extent in the embryon, and as soon they begin to harden and form their cortex in the middle, the tube of the bone becomes apparent.

In addition to the causes stated above, it is very probable that another circumstance takes place in the increment and evolution of the pituitary sinuses—that is, as the body increases, the capacity of these sinuses gradually enlarges, and the extent of the spongy bone surrounding them is increased, at the same time its thickness is diminished, until this bony sponge forms the walls of the pituitary sinus. There will be less doubt in relation to this, if skulls of all ages, from the fœtus at birth to the adult, be carefully examined, in which it is very manifest that the amplitude of these sinuses are in the inverse ratio of the spongy cellulous substance of the bone, which in the fœtus surrounds these cavities. But to these causes promoting the increment of the pituitary sinuses that may be properly called *primary*, I think that those *secondary* cases should be added, depending from the change of figure and position which the surrounding bones of the embryon are subject to.

The convexity of the superior and middle turbinated bones being increased towards the septum narium, favours the expansion of the æthmoid cells, and the appearance of the molar teeth in the child, with an increased convexity of the alveolar process, aids much in developing the maxillary sinus—in proof of which, the maxillary cavity is much lessened when the molares fall out, and the alveolar arch is removed. When the root of the nose and and outer surface of the frontal bone is raised in children, this causes the æthmoid cells to be raised upwards along with them, so that the superior cells get a new place and name, and are called *frontal* sinuses. Should any one suppose the air during respiration to be impelled throughout these sinuses, I should not be much disposed to object.* I will

* The air has access to the sinuses during respiration, when they are not diseased—but it is not necessarily *changed* at every breathing, as is evinced by the occasional retention of a peculiar odour which is proved by its re-appearance after a lapse of time, and our removal from the spot where it was first experienced. J. D. G.

end this essay by pointing out the propriety, in similar researches, in order to understand the most interesting articulations of the body, of employing a recent subject in which the bones are held together by their own peculiar ligaments. Experience has taught me that dissectors have often fallen into error, from want of a recent subject before them to examine and correct their notions.

In dried bones, for instance, deprived of their ligaments, any one would say, judging from the appearance of the head of the bone and the acetabulum, that a man could readily move the thigh bone in every direction—could flex, extend, adduct, or draw one thigh to the other. Nothwithstanding, I venture to assert, that it is most certain we have not the power of extending the femur, that is, to carry it behind the perpendicular line of the whole body. If we stand on one foot, and attempt to move the thigh behind the perpendicular line of the body, we find that we are altogether unable to accomplish it, and if we appear at all to succeed, it is only in proportion as we bend the trunk forwards above the hip joint. The unequal thickness of the capsular ligament of the hip joint, and the peculiar disposition and insertion of this ligament into the neck of the femur, prevents the extension.*

* By reference to the description given in the previous part of of this volume of the manner in which the capsular ligament of the

The capsular ligament below the psoas magnus and iliacus internus is very thin, and is thinnest behind, where it is covered by the quadratus femoris. But on the outer part where the capsular ligament is thickest and densest, it does not go directly downwards, but passes obliquely from the outer part of the brim of the acetabulum, and is inserted in the interior surface of the root of the neck of the thigh bone.† On account of this insertion, as we attempt to carry the femur backwards, the anterior, which is firmer and denser than the posterior part, is strained to the utmost and forcibly extended, preventing entirely the tension beyond the *perpendicular line.* That this principally depends on the unequal thickness of the capsular ligament, is shown and proved by opening this ligamentous capsule on the side of the foramen ovale, and thence introducing a knife so that the round ligament may be divided—nevertheless, although in the most recent subject, we cannot perceptibly move

hip joint is formed from the *fascia lata,* the reader will be better able to perceive the correctness of Scarpa's assertions, inasmuch as he will find another reason for their truth in the connexion which all the muscles of the thigh have with the capsule. He will also be well prepared to understand the cause of the inequalities in the thickness of this ligament. J. D. G.

† See Weitbrecht, *Syndesmologia,* Tab. xviii. fig. 53. Godman's *Anatomical Investigations,* Sec. v.

it backwards beyond the perpendicular line. How much these facts will assist in more clearly understanding the circumstances which in health to pertain to the mechanism of standing, walking, leaping, or in disease, to the diagnosis and removal of luxations of the thigh, it is unnecessary for me to point out to any one at all acquainted with the subject.

ERRATA.

Page 6,—3d line from top, after " than" strike out " to."

16,—4th line from the bottom, for " ileum" read *ilium.*

45,—9th line from the bottom, for " then" read *than.*

47,—for " prostrata" read *prostatæ.*

51,—3d line from bottom, for " prostrate" read *prostate.*

55,—6th line from bottom, for " conversity" read *convexity.*

73,—2d line of the note for, " display" read *displays.*