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ORATION ON HARVEY'S "EXERCISES ON GENERATION."

Delivered at the Royal College of Physicians, on June 26th.

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PRESIDENT AND FELLOWS,—This day serves to recall an event which, two hundred and fifteen years ago, must have been the occasion of much sorrow to the Fellows of our College then assembled. On the 26th of June, in 1657, Harvey was carried to his grave, a long train of his friends and colleagues following far beyond the city walls.

But of Harvey dead it is not my purpose further to speak. Rather let us regard him as living still among us, in the records of his works, in the memory of the benefits which he conferred upon this College, and in the bright example of his character and mind. On any occasion on which the countrymen of Harvey meet, with the object of carrying out his expressed wish, that annually an oration should be delivered, no difficulty need be felt on the part of him who is appointed to that duty in finding a subject suitable to the purpose. And although, in accordance with custom, such address need have no reference to the founder, further than with a view of recalling his desire to mind, that the orator should "exhort the members of the College to study and search out the secrets of Nature by way of experiment", yet, should the speaker find in Harvey's works matter which may have been selected by himself for particular study and investigation, he would naturally take that subject as furnishing him with the best material. It is on this ground, therefore, that I have taken the subject of *Generation*, as exemplified in the celebrated *Exercises* of Harvey, which, although constituting by no means the more important of his two great works, yet forms the larger one, and that which, at the same time, is perhaps the least generally read. It does not appear, moreover, from an examination of former orations, that this subject has been selected before; so that here I have the advantage—if, indeed, it be an advantage—of occupying untrodden ground.

In order that we may the better understand Harvey's position, when he commenced these studies of which the ultimate fruit was his celebrated treatise on *Generation*, it is desirable to bear in mind the prevalent physiological doctrines of that day. Harvey found the teachers of this branch of physiology divided into two principal parties. According to the teaching of Aristotle, the principles of generation were the male and the female, she contributing the matter, he the form; and immediately after conception the vital principle, and the first particle of the future foetus—namely, the heart, in animals having red blood—were formed out of the secretions of the uterus. On the other hand, the followers of Galen, with whom were the physicians, taught that the semen of both parents alike, combined, furnished the offspring, which resembled one or other according as this or that predominated, and that by virtue of such predominance it became either male or female.

Neither of these doctrines, however, gave satisfaction to Harvey, but the contrary. "That they are erroneous and hasty conclusions," he says, "is easily made to appear: like phantoms of darkness they suddenly vanish before the light of anatomical inquiry"; nor, he adds, "is any long refutation necessary, when the truth can be seen with one's proper eyes, where the inquirer, by simple inspection, finds

everything in conformity with reason; and where, at the same time, he is made to understand how unsafe, how base a thing it is to receive instruction from others' comments, without examination of the objects themselves, the rather as the book of Nature lies so open, and is so easy of consultation."

That Harvey assigned to himself the path of direct observation, as the only one which could satisfy him, is rendered plain by what I have just quoted. And in what way, and by what reflections, he intended to sweeten his labour, appears further from other passages, in which he has recorded his thoughts in language so illustrative of his own mind and character, that I cannot resist giving this also. "Nor is there any just cause," says Harvey, "wherefore the labour should deter any one, and neither indeed would the way I propose be felt as so barren and lonely, but for the custom, or vice, of the age we live in, when men, inclined to idleness, prefer going wrong with the many to becoming wise with the few, through dint of toil and outlay of money. And truly in such pursuits it is sweet not merely to toil, but even to grow weary, when the pains of discovering are amply compensated by the pleasures of discovery." It were disgraceful, therefore, with this most spacious and admirable realm of nature before us, and where the reward ever exceeds the promise, did we take the reports of others upon trust, and go on coining crude problems out of these, and on them hanging knotty and captious and petty disputations. Nature is herself to be addressed; the paths she shows us are to be boldly trodden for thus, and whilst we consult our proper senses, from inferior advancing to superior levels, shall we penetrate at length into the heart of her mystery."

That Harvey designed to write a systematic work on generation upon a large scale cannot, I think, for a moment be questioned by any one who carefully examines these celebrated Exercises. But that the work which has come down to us under this title is not that complete one which Harvey had contemplated, and must at one time have hoped to finish, is, I think, equally removed from doubt. In fact, the seventy-two exercises of which the treatise mainly consists should be regarded rather as constituting the materials out of which a more perfect book should be constructed. Many circumstances appear to lend colour to this view, but more particularly the great unwillingness of the author to part with it in its present form.

This we learn from Sir George Ent, to whom, perhaps, we are indebted for its publication at all, or, at any rate, during Harvey's life, and who thus graphically describes the circumstances under which he became possessed of it. Having waited upon Harvey, who had then in a great measure retired from public life, Ent, after some introductory conversation, proceeds to unfold the object of his visit by representing to the great physiologist that the world was still looking for some further work from his hands. To this Harvey replies, "And would you be the man who should recommend me to quit the peaceful haven where I now pass my life, and launch again upon the faithless sea? You know full well what a storm my former lucubrations raised. Much better is it oftentimes to grow wise at home and in private, than by publishing what you have amassed with infinite labour, to stir up tempests that may rob you of peace of mind for the rest of your days." Ultimately, however, the persuasive power of Ent appears to have overcome the reluctance of Harvey, who, giving up his papers, consented to their publication, either immediately or at some future time. Ent, having thus accomplished his purpose, retires with Harvey's portfolio of notes under his arm, feeling, as he says, like another Jason, laden with the golden fleece; and, after eagerly examining the contents, he hastens to carry out his promise of undertaking the correction of the press, and ultimately of performing what he terms the "midwife's part", by ushering into the light "this product of his colleague's genius".

But here it should be remarked that these exercises bear no evidence of having been carefully revised by the author previous to publication. Indeed, it is obvious that this was not the case; otherwise numerous continually recurring passages would have been omitted or abbreviated, and statements which appear in a certain sense to be antagonistic to each other would doubtless have been reconciled or explained. On account of this omission, which is the more to be regretted in a work bear-

ing evidence of much devoted labour, and of the application to it of a mind of great power, very considerable and almost insuperable difficulties are sometimes encountered in the attempt to arrive at the author's precise meaning in regard to certain important particulars of which he treats.

Harvey commences his work on the generation of animals with the study of the egg; and, after explaining what he understands by an egg, he proceeds to select two examples which are marked out for special investigation.

The egg of the common fowl being readily obtainable, and admitting of comparatively easy observation, this is selected as Harvey's first study. But this particular path had been already trodden by two previous observers; viz., Aristotle among the ancients, and Fabricius of Aquapendente among more recent authors. Neither of these, however, had carried their observations to an extent sufficient to satisfy Harvey's mind, and accordingly we find him setting to work, and by his own labours endeavouring to supply what appeared to be wanting in the observations of either or both of these.

After devoting no fewer than sixty-two exercises to this special object, he proceeds to select a second example from the viviparous class; not, however, without first pointing out the artificial nature of the distinction between oviparous and viviparous reproduction. He asserts that such a division does not satisfy him, inasmuch as all animals whatsoever may be said, in a certain sense, to proceed from ova, and are entitled respectively oviparous or viviparous, rather in respect of their mode of bringing forth than of their first formation.

The second example chosen is from the viviparous class—and here he had advantages which neither of his predecessors possessed; for the liberality of the King, his master, had placed at his disposal the costly occupants of the Royal Parks, and from these he was permitted to select as many examples as might serve his purpose. Of this privilege Harvey fully availed himself; and to this opportunity we are indebted for those valuable and original observations on the gestation of the hind and doe which constitute some of the most valuable portions of Harvey's work. Interwoven with these observations, we find constant reference to the doctrines of Aristotle and of Fabricius, together with occasional quotations of the opinions of others; and when to these are added the speculations of Harvey himself, which we find scattered through every portion not only of the exercises but also of the four additional essays with which the work concludes, we shall have enumerated the leading features of Harvey's remarkable and most interesting treatise. Remarkable and most interesting it may well be termed, when we consider the circumstances under which its composition was attempted; for scarcely were any of the facts yet discovered upon which a consistent theory of generation might be based. Not one, indeed, of the main points which constitute the foundation of our present views regarding the physiology of this subject, had yet been ascertained. A long interval had still to be bridged over before the first of these elementary facts was fully established. And when now, looking back upon the past, we see with what persevering industry, and by what a long series of observation, conducted by many fellow-labourers, or rather by many labourers working in the same direction, the knowledge which we now possess has been gradually and slowly acquired, and contrast this with the comparative ignorance—it might almost be said the absolute darkness—which prevailed in Harvey's day, we may well contemplate with admiration the courage and energy of the man who, in the face of such difficulties, could assign to himself the task of composing a systematic work on the subject of generation.

Nor must we forget that the microscope, infinitely the most important instrument of research now possessed by physiologists, was at this period practically unknown. We do, indeed, find indications of some simple inventions with which magnifying power must have been associated, though they may not, perhaps, have been used for optical purposes, at a very early date indeed; and possibly of this nature were those burning glasses to which Aristophanes, in his comedy of *The Clouds*, makes reference. Moreover, lenses, such as are now used by engravers, are said to have been found in the ruins of Herculaneum. And even Harvey himself had some knowledge of magnifying or burning glasses; for, in speaking of different modes of producing fire, he says, "Nor even is a spark necessary, since by the solar rays transmitted through a small piece of glass, and concentrated to a focus, fire may be immediately produced, and the largest things be set on flames." But down to a period ten years later than Harvey's death, when the discovery of the spermatozoa was first announced by Leeuwenhoek, the microscope was so little known, and, even when known at all, existed in such an imperfect form, that Leeuwenhoek found it necessary to construct with his own hands not only the lenses, but even the framework of the very primitive instruments with which he conducted his observations.

One other point may also be noticed with reference to Harvey's original design. His observations were not limited to the vertebrate series, from which he had selected the two typical examples just named, but they were also extended to the invertebrates. This we may gather from several passages occurring in his work, but more particularly from the statement which he made to Ent as one ground of objection against parting with his papers—namely, that they must be held to be imperfect, as not containing his investigations on the generation of Insects—a class which is second to none in the whole range of the animal kingdom for the information which it affords in the study of this process. Harvey appears to have bestowed much care upon these, and his distress at the loss of them was correspondingly great. As Aubrey describes it, "they contained many curious observations; but these, together with his goods at his lodgings at Whitehall, were plundered at the beginning of the Rebellion; and he often said that, of all the losses he sustained, no grief was so crucifying to him as the loss of these papers, which for love or money he could never retrieve or obtain." This, indeed, is the only point upon which we find, throughout Harvey's exercises, any expressions of this kind uttered by himself. Something in the course of his observations having occurred to him, upon which he desired to get further information, he refers to the circumstance noticed by Aubrey in the following touching expressions. "Whilst I speak of those matters, let gentle minds forgive me if, recalling the irreparable injuries I have suffered, I here give vent to a sigh. This is the cause of my sorrow. During our late troubles, and more than civil wars, certain rapacious hands stripped not only my house of all its furniture, but, what is subject of far greater regret with me, my enemies abstracted from my museum the fruits of many years' toil; whence it has come to pass that many observations, particularly on the generation of insects, have perished."

From this brief reference to the general scope and purpose of Harvey's work on generation, I pass on to notice more particularly some of its leading features, and to compare them with the established facts and doctrines of the present time; and, if any apology be needed for the tracing out of these in a certain historical order, I trust it will be found in the fact that many of our present views can be shown to have their representatives in the doctrines of a past age; and that what we occasionally regard as discoveries have been anticipated, in thought at least, by many of our predecessors. And, by way of introduction, I will proceed to consider what were Harvey's views in regard to the commencement of animal life. The dictum, "*Omne animal ex ovo*," or, as often quoted, "*Omne vivum ex ovo*," is commonly ascribed to Harvey; but, if any one desire to find in the exercises this phrase, in the aphoristic shape here quoted, he will, I think, be disappointed. There can be no question that the expression "*omne vivum ex ovo*" serves to represent in general terms the particular doctrine which it was a main purpose of Harvey to teach. It cannot, however, be said to be his exclusive doctrine, since he frequently uses certain qualifying phrases. Nor is it quite clear that he is averse from admitting the possibility of so-called spontaneous generation; as, for example, in the twenty-eighth exercise, where he says that "some animals arise spontaneously, or, as is commonly said, by putrefaction."

But, not to dwell here upon this last subject, to which, if time permit, I hope to return later on, we may proceed to inquire what Harvey understood by an egg. It would be easy to select passages illustrative of each of the particulars just noticed; but no single one, perhaps, could be found more generally representing his views than the following, taken from his sixty-third exercise. After referring to the statement of Fabricius that the greater number of animals are engendered from eggs, he says, as it were impatiently: "Now we, at the very commencement of our observations, affirmed that *all* animals are, in a certain manner, produced from eggs; for in the same sense and order in which a chick is formed and developed out of an egg, equally in the same manner is the fœtus of viviparous animals engendered from a pre-existing conception. Both species of generation constitute one and the same thing; and the beginning of either is termed an egg, or at least something which by analogy may be so regarded." And then he goes on to say, "For it is generally admitted, and is indeed manifest, that all embryos, even of man himself, are procreated from some conception or a certain primordium. And the matter stands thus: that which in things arising spontaneously is a primordium, in plants is seed, and in oviparous animals an ovum."

Further, it is a prominent feature in the work of Harvey, that he held the doctrine of epigenesis, of which he was one of the earliest advocates, against that of metamorphosis, in the sense in which it was maintained by Fabricius, as well as that of evolution or preformation, the favourite doctrine, more especially of a later time. Harvey leaves us in no doubt as to what he means by epigenesis. In his forty-fifth and fifty-first exercises, as well as elsewhere, he says, that from his his-

tory "it appears clear, that the generation of the chick from the egg is the result of epigenesis rather than of metamorphosis; and all its parts are not fashioned simultaneously, but emerge in their due succession and order." That there first exists a particular genital particle, in virtue of which, as from a beginning, all other parts proceed. That the origin, growth and consummation are brought about by a method of nutrition, and that at length the foetus is thus produced. This is Harvey's doctrine of epigenesis, as stated by himself. And if we were to follow out these views to a later period, we should find him supported by Malpighi and by Wolff; while, on the other hand, carrying the investigation in an opposite direction, we should find Haller and Bonnet entirely opposed to these views. Haller maintained that the parts of the foetus, although invisible, nevertheless exist in the egg, and that these, becoming gradually expanded or unfolded by degrees, constituted the embryo. But Bonnet's views represented another phase of the same doctrine, for he maintained that not only are all the parts of the foetus pre-existent in the ovum, but that all germs, past and prospective, those that have been, and those that are yet to be born, were all existent in the ovary of the original parent; that these germs lie dormant in their abode, until one or more are aroused by the exciting influence of the male; and that, consequently, there is not in nature the new formation of any animal.

But these speculations, in so far as they are opposed to the doctrine maintained by Harvey, might be easily let alone, were it not that the controversy thus raised has been sustained, though with sundry variations, ever since. And although the ground has been in some respects shifted, yet the terms are retained, and the general principles involved in these two opposite doctrines represent the divergence of opinion exhibited by two opposite parties in the present day.

Drelincourt, whose principal work was published two centuries ago, collected together two hundred and sixty-two groundless hypotheses relating to the process of generation; the exact number I give upon the authority of Blumenbach. But whether rightly estimated or not, the result of all this labour appears to have been, that Drelincourt's own theory came in turn to be regarded as constituting the two hundred and sixty-third. And should a second Drelincourt appear, some two centuries hence, or possibly in less time, may he not perhaps find, in some of our own cherished theories, matters that may seem then quite as fanciful as those of which we have just been speaking?

I will now venture to draw your attention to some of the leading facts regarding the process of generation which have been ascertained since Harvey wrote, and especially those of recent times. Reversing the order which Harvey adopts, I will commence with the consideration of the part which the male contributes to the process of generation, a subject of which Harvey had no real knowledge. And this brings us at once to what is the most curious part in the history of those several discoveries which have led up to our present complete knowledge of the subject of generation. No physiological fact, perhaps, was ever established with greater difficulty than that of the necessity of the sperm-cell, or spermatozoon, for supplying the material or means by which the fertilisation of the ovum is accomplished.

Two hundred years and more have been occupied in the investigation of this part of the subject, and during this period the sperm-cell has been submitted to examination under microscopes of every form of construction, by observers, incompetent as well as most competent, and has given rise to numerous speculations, some of which may be said to represent the highest flight of human imagination, while others—and these, happily, the more numerous—bring us to the firm ground of sober truth. I cannot venture to take you through all this wilderness, which, on casting back our eyes, we see decaying or dead behind us. The more ridiculous fancies, the mushrooms of the day, perished of themselves long ago. But to other and more sturdy growths it was found necessary to apply the pruning knife or the axe, until at last we have arrived at materials sufficiently definite to admit of our basing upon them sound and rational conclusions. Some, indeed, of the more important conjectures which from time to time have been offered regarding the use of the spermatozoa must of necessity be noticed, in speaking of the mode in which the fertilisation of the ovum is effected. It will suffice, therefore, if we now examine briefly the structure and mode of formation of these bodies, as far as microscopical examination has yet gone.

The sperm-cell appears to undergo a process of development closely analogous to that of the germ-cell, which we shall have presently to trace: and since no material variation is observable in the formation of the spermatozoa in the different classes of vertebrates, the description of any one may serve for that of the rest. Hitherto in considering this subject, the term "sperm-cell" has been employed as a general expression, and as the equivalent of spermatozoon; but in speaking now of the development of these bodies, a greater strictness must be

observed. Taking the Mammalia as a type, the testes are found to contain in considerable quantity free cells, the so-called parent cells. Within each of these again are found several smaller cells, the daughter cells or vesicles of development—each daughter cell containing a separate spermatozoon. These, by their growth, burst through the delicate cell wall that confines them, and, escaping into the parent cell, become aggregated into bundles, or lie coiled in the interior. Ultimately this outer wall bursts, and the spermatozoa are set free: they are not, however, generally as yet fully developed; they appear to go through a further process of growth, which has much engaged the attention of microscopic observers of late, and which seems to have not altogether escaped the attention of Leeuwenhoek, their discoverer, if we may credit the very extraordinary illustrations which are to be found in his work, not without some help, apparently, from the imagination of the artist.

When fully formed, the spermatozoa present very remarkable differences in different classes and species. These relate chiefly to the part commonly termed the body or head—for the caudal appendage is very similar in all, the chief difference being in its greater or less length. The variations just mentioned may possibly have reference to the mode of penetration of the spermatozoon within the ovum, according to the greater or less thickness of the enveloping membrane of the latter; but that which microscopic observers are at this time most intent on discovering is the nature and arrangement of those small granular particles which constitute as yet all that has been distinctly seen in the interior of the body, and which respond to the test of staining with carmine precisely in the same way as the granular contents of the ovum, while much observation has been expended and much speculation hazarded in the effort to determine the means by which the vibratory motion of the spermatozoon is effected. But even if nothing more satisfactory can be discovered than that which is already known, we may still safely regard this little portion of granular matter as constituting the living material that confers fertilisation upon the ovum, while we may look upon the vibratile appendage as the instrument by which this is carried to its destination, and the continuance of its motion as the sign that the power of conferring fertility is still retained.

We may now turn our attention to the part which the female contributes to the process of generation. "*Propter solum uterum est mulier id quod est*" is an aphorism often quoted, and originating with Van Helmont, a contemporary of Harvey; but the idea which it is intended to convey of the greater influence and importance of the uterus was the dominant one long anterior to Van Helmont's day. Take, for example, what Aretæus says of it in his wonderful description of that organ, and of its mode of producing hysteria and various other affections. "In the middle of the flanks of woman lies the womb, a female viscus, closely resembling an animal; for it is moved of itself hither and thither in the female, also upwards in a direct line to below the cartilage of the thorax, and also obliquely to the right or to the left, either to the liver or spleen; and, in a word, it is altogether erratic." Then, after describing the preference of the uterus for certain odours and its aversion to others, so that it advances towards the one or flees from the other, Aretæus concludes by saying that, "on the whole, the womb is like an animal within an animal". The leading idea which underlies all this extravagant expression is obvious enough. It is plain that Aretæus intended to represent the uterus as the principal agent in the production of those symptoms, which he here, however imperfectly, endeavours to describe. Doubtless here the term uterus is made to include the ovary, with the rest of the reproductive organs; and in this sense, as a comprehensive expression, we may be excused for employing it, as we still do, in the conventional language of the present day. But the time has long arrived when physiology, and especially pathology, might derive advantage from greater precision in the separate use of these several terms. In a physiological sense, the uterus, together with every other portion of the generative apparatus, should be regarded as an appendage of the ovary. In many animals it has not even an existence, as in Fishes and Batrachians, where the ova are expelled previously to fertilisation, and no uterus is needed. But in those classes in which it is found, the office of the uterus must be regarded as supplementary to that of the ovary. Its presence there, indeed, is necessary to complete the act of reproduction in its regular course, since it is the organ which receives and nourishes the ovum after conception, and it is the part which serves for its expulsion when sufficiently developed. But these are offices obviously subordinate to those of the ovary. On the other hand, the ovary is that part in which the generative element, essential to the act of reproduction, is first formed. It is that part which appears to regulate, in a great measure, the growth of the body, and to determine the periodical recurrence of conception and of other functions. When the ovary is artificially removed from the body, the individual becomes unsexed; and when its functional activity declines

or ceases, the power of exercising the generative faculty is altogether lost.

In every sense, then, the ovary must be regarded as the more important organ; yet its structure was little known in the times of which we are now speaking, and consequently its offices and homologies were entirely misunderstood. By Harvey the ovaries, in accordance with the then prevailing custom in regard to human anatomy, are almost always termed the testes; though he does, indeed, suggest that the ovaries appear to bear analogy to the male gland as regards Fishes. The merit of having been the first to announce an opinion that the so-called testis is to be regarded as analogous to the ovary is due to De Graaf, who in 1667 gave a full account, with most accurate illustrations, not only of the ovary, but also of the oviduct as well as of the corpus luteum. In his well known work he describes the use of the ovary as being to generate, to nourish, and to bring to maturity the ova; and further he suggests that these should be termed ovaria rather than testes, since no similarity either in form or in contents can be traced between the two.

We must, indeed, wait until a much later date before we arrive at a time when the structure and functions of the ovary and its contents began to be thoroughly understood, and this period may be fairly considered as having its commencement with the discovery, in 1825, of the "germinal vesicle" in the ovarian ovum of Birds by Purkinje, followed, two years later, by the observation of the ovum in the Mammalia by Baer.

[To be continued.]

LECTURES ON HUMAN MYOLOGY.

*Delivered at the Royal College of Surgeons
of England.*

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LECTURE II.—*June 19th, 1872.*

IN the former lecture, Mr. President and gentlemen, I endeavoured to show that the muscles of the trunk, ventral as well as dorsal, are derivatives from or modifications of the elementary tissue which, by other modifications of the developmental processes, is converted into the transversely segmented lateral muscle in the Fish. I proceed now to indicate that the same is true to a considerable extent of the muscles covering the limbs.

The muscular system, as well as the various other features of the upper and lower limbs, affords an interesting example of the influence of similar morphological impulses operating upon similar or serially homologous elements of the frame, yet modified by the special future requirements of each limb. One limb is like the other, and is evidently the produce of similar germs, moulded by similar forces; yet the one limb, upper or lower, cannot be regarded as in any way a modification of, or a descendant from, the other. Neither is it quite certain that we should assume both to be modifications of, or descendants from, a common simple form. True, as we trace them back through their primitive developmental conditions, they seem to present a greater resemblance to one another, and ultimately to blend, together with the other structures of the body, in a formless unit. Still it must not be forgotten that the greater similarity in the earlier periods of development, as compared with the later, may be due simply to the peculiarities of each being less obvious—less within the range, that is, of our limited powers of observation. Each limb, from its initial as an individual—from its first outgrowth from the common mass—may be, and, so far as we know, is, potentially endowed with its special characters. Each originates, by an independent force, in its proper locality; and each by that same force works its way along its special path to its fitness for its special work. The forces in the two are, however, similar, and the materials are similar; and hence the result is similar, so far as is compatible with the purposes of each.

These remarks, suggested by the comparison of the two limbs of man with one another, apply to the comparison of the limbs of man with those of other animals. We really have little right to assume that any of these is a modification of any other, or that all or any of them are descendants from, or modifications of, a common simple form; though many things may incline us to that view. It is clear that they are all the produce of similar forces, working in a similar

manner upon similar materials, and leading to results similar so far as is compatible with the purposes of each. How these recondite forces originate, and how, in each limb of man and in the several limbs of the different animals, they evolve the form and structure requisite for each, is perhaps at present a fruitless subject of inquiry; at any rate, it is foreign to my present purpose.

The limbs grow out from their respective girdles, which, being ossifications in corresponding parts of intermuscular septa in the ventral portion of the lateral muscle, are serially homologous elements, though each is found to suit the requirements of its limb. By the ventral portion of the lateral muscle I mean the elementary structure, which in the Fish would have formed the ventro-lateral muscle. It will be observed that the girdles are formed essentially in the ventral part of the lateral muscle—the part beneath the lateral septum; and have no primitive connexion with the components of the dorsal series of muscles. This is evident in the lower animals, though in Man, and many of the higher animals the ala of the ilium has grown up into, partially interrupts, and has come to form an important basis of attachment to, the erector spinæ. As the osseous elements of the limb grow out from the girdles, they carry before them, or are covered by, a coating—a ventro-appendicular coating—composed of the elements which cover the girdles. These become developed into tissues—cutaneous, cellular, muscular, vascular, nervous, etc.; and they are severally continuous with the corresponding tissues that cover and surround the girdles. This is the case with the muscular tissue no less evidently than with the skin and the cellular tissue; and the muscular tissue in each limb forms a funnel-like investment surrounding the base of the limb, and extending upon it beneath the skin and the cellular tissue. In Man it does not, as do the skin and cellular tissue, retain its continuity over the whole limb; and it does not retain its connexion with the trunk-muscles or other components of the lateral muscle in its whole circumference. Still sufficient traces of these connections remain; and they are more fully preserved in some of the lower animals. The continuity is perhaps seen in its simplest, most complete, and most instructive form, in the rudimentary limbs or claws of certain Snakes, where the thin muscular investment radiates from the claw upon the adjacent region of the trunk.

In the case of the upper limb, which, together with its girdle, is freely movable upon the trunk, the funnel-like ventro-appendicular muscular investment is a main agent in effecting these movements. It is accordingly well marked, and is nearly a complete funnel; and its base is seen to radiate for some distance in the circumference. Indeed, its surrounding attachments range as widely as they can possibly do; and they thus give the fullest scope to the action of the component muscles. Above, it spreads to the head; below, to the pelvis; behind, to the vertebral spines; and in front, to the sternum and middle line. It is segmented into three sectors or parts—the pectoralis major, the trapezius and deltoid or trapezio-deltoid, and the latissimus dorsi. These all lie in the same plane. I may remark that the slight deviation from this, caused by the trapezius overlapping the latissimus dorsi at their origin, is of no particular import. In Birds and some Reptiles, the reverse arrangement is found, the latissimus dorsi overlapping the trapezius. All the sectors converge to a little above the middle of the humerus, so as to swing the limb with great force and freedom in every direction. I need scarcely say that the convergence and tendinous insertion of so many muscular fibres at this spot, is the cause of spontaneous fracture, and of failure of union after fracture being far more frequent at the middle of the humerus than in any other of the long bones.

The lines of division of the funnel-like sheath into the three sectors correspond, in the first place, with the passage through it of the marginal vessels and nerves of the limb—that is, the external cutaneous or cephalic vein and the accompanying artery above, and the internal cutaneous or basilic vein and the nerves below. These separate the pectoralis, or palmar, portion from the trapezio-deltoid and latissimus dorsi, or dorsal, portion. Secondly, the two sectors of the dorsal portion separate, to pass to the humerus on the two sides of the triceps extensor muscle of the forearm. The fibres of the contiguous binder or axillary margins of the pectoralis and latissimus dorsi usually disappear, or are not developed, leaving the axillary interval between the two muscles. Not unfrequently, however, bundles are found crossing and partially obliterating the interval by connecting the two muscles together; and in some animals, as *Lepidosiren*, the two muscles form a continuous sheet.

The anterior or cervical interval between the palmar and dorsal sectors of the ventro-appendicular sheath appears to be large above the clavicle, in consequence of the divergence of the pectoral from the trapezius; but the gap is in great measure filled by the sterno-cleido-mastoid, which, as stated in the preceding lecture, is the continuation of