INAUGURAL THESIS

ON

THE GUBERNACULUM

BY

JOHN CLELAND.

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Preface.

The principal object of the following essay is the elucidation of the disputed structures generally comprehended under the name Submammalian Hunter's Testis. This study involves the consideration of nearly the whole subject of the descent of the testis. In addition to this I have prepared a sketch of the development of the testis and its ducts, a subject on which much has been incorrectly written. The treatment at so great length of the mechanism by which the testis descends has naturally led me to inquire what is the purpose of this remarkable change of site, and on this subject are added some attempts at explanation which may serve to throw light on the subject.

John Cleland.
Thèse sur les Corps de Wolf, à Paris 1850. The summary is given in a review in the "Archives générales de médecine" Tom. XXV 1851. p. 330.
Although the subject to which this thesis is principally devoted, is the descent of the testicle through the abdominal wall to the scrotum, an account of the development of that organ and its ducts will not perhaps be considered an inappropriate introduction, connected as it is with the descent from below the hind to the groin. I am induced to enter on this topic as it is one on which little has been written in English, one on which many conflicting opinions have been held, and to which I happen to have given some attention.

The most accurate account of this complicated problem in development has been given by M. E. Folliot in 1860.

To treat the subject properly we must commence with the Wolffian bodies.

In a foetal sheep, half an inch long these organs extend the whole length of the abdominal cavity, parallel to the vertebral column closely in contact. They are formed
Müller's Physiology. p. 1554

Arnold, Anatomie des Menschen. vol II p. 1330
of tubules which end at the gland extremity in dilatations like the Mammillary capsules of the kidneys, and at the other join this excretory duct. This duct has usually been held to run along the external aspect of the gland, & such indeed is its primitive position; but in the advanced state it pierces its lower end and seemingly ascends in the centre as was held by Müller, while the duct which is then seen along the side—the Müllerian duct as it is called—is a formation only for the generative apparatus. According to Tüllin, the duct of the Wolfian body is on its external aspect at first, but becomes imbedded among the increasing convolutions of the tubules. It opens into the lower part of the Alantorix.

The reproductive organs, whether testicles or ovaries, make their first appearance along the internal border of the Wolfian bodies in the form of a white streak, and are parallel to one another on each side of the spinal column. It is at this time impossible to say whether they are to be testicles or ovaries. Arnold describes the testicles probably developed from the elongations of the tubules of the Wolfian body, which are transformed into the seminal tubules, but they are formed in reality from independent portions of blastema. As the kidneys grow they appear above & internal to the Wolfian bodies, and the latter come to occupy an oblique position as if they were separated by them. If the animal is to be a female their declination is continued till they are nearly in the transverse position, and
this furnishes one of the earliest sexual distinctions. The reproductive organs are at first of an elongated form, and, if they are destined to be ovaries, they retain that shape and exhibit a deep groove along the external aspect, where they are joined by the peritoneum to the Wolffian bodies. If on the other hand they are to become testicles, they assume a round form and remain solid, and the contained blastemes soon commence to arrange itself in transverse rows. The peritoneum now invests the testicle completely, and in the sheaf and calf it soon forms a ligament or mesorchium of considerable length between the testicle and the Wolffian body. In this membranous duplicature a process is observable arising from the posterior and upper aspect of the former organ, & proceeding downwards & somewhat forward to the latter, on whose anterior surface it can afterwards be traced to a junction with its principal pedicle. In the meantime small vesicles surround it, its centre is ultimately hollowed and becomes the cavity which in the animals above mentioned becomes remarkably convoluted. This has been mistaken sometimes for the first appearance of the excretory duct of the testicle. (Illustration I.)

While the above changes are going on, the Müllerian duct is developed along the outer border of the Wolffian body, & from its own white color contrasts with the red of the already diminishing gland. It ends at the upper part in a small bundle of convoluted tubules. Both duct and tubules were supposed by
Kobelt. Du Bœvovarium chez la femme l'analoge de l'épididyme chez l'homme. The summary is extracted in the Archives Générales de Médecine t. XXV p. 327.
Robert and others to be formed from the duct and tubules of the Wolfian body; but M. Böde, afterwards Dr. T follini have shown that they are distinct structures from those. Below the level of the Wolfian body, the prolongation of that organ is closely united to, & ultimately blended with the Mullerian duct (Follini); but above that point, the former is hid away or lies in the substance of its gland, while the latter continues along the outer side. As to the convoluted tubules at the upper end of the Mullerian duct, they are indeed formed at the expense of the Wolfian body;—that is, in a position originally occupied by the latter, so that a part of it must be absorbed before them, and this is evident, since the upper extremity of the testicle is now on a high a level as that of the Wolfian body, though originally on a lower. But they cannot be composed of the canals of that organ transformed, for were this the case we should find them consisting of hollow tubules from the first, whereas they begin at solid bands indistinctly separated, and smaller than the Wolfian tubules. This little mass of tubules becomes joined by a short straight cord to the upper part of the testicle. (Illustration III)

The Mullerian ducts in the female are destined to form the Fallopian tubes and end in a slight bulbous enlargement surrounded by a mass in which may be seen strie analogous to the tubule just mentioned in the male, the first rudiment of the fimbrice. At their inferior extremity these ducts
Bischoff on Development, translated into French by Courdon. Cyclopedia d'Anatomie, vol VIII, article, Testicle.
are united in the female to form the uterus. The ducts of the Wolfian body remain separate, and are said by Tollin to pass as hollow tubes which open into the lower part of the vagina & form the ducts of Gartner. (Illustration III, Fig. 1.)

As the male embryo increases, the Wolfian body is found in an atrophied condition, separated completely from the ducts of the testicle at every part (in the calf at least) except the upper extremity, which is still in close contact with the convoluted tubule anala. It has the appearance of transverse granular bands. The substance of the testicle is now separated into convolutions, which seem to beat first without any membrane, but afterwards bounded by a homogenous membrane evident on addition of acetic acid. Bischoff maintains that the tubuli seminiferi are formed of blended cells, but in this opinion he is singular.

As the development goes on, the cord joining the testicle to the excretory part becomes striated longitudinally, & each strie becomes a distinct vas efferens. The convoluted membra into which this cord enters, may with care be now shown to form only the coni vasculosi, and not more of the epididymis than the portion into which they are inserted; for by very slight unravelling several of the fine tubes forming its convolutions may be seen given off from the main duct. The rest of the epididymis is formed by that part of the duct which ran along the side of the Wolfian body, and the remainder of this course
is the vas deferens. The separation between the vas deferens &
epididymis is marked by a few sharp turns, and this point is
at just some distance below the level of the testis (Illustration III)

In the female the duct makes a twist at the corresponding point
and this marks the termination of the cornu of the uterus and
commencement of the Fallopian tube. (Illustration III, Fig. F, I)

At the uticle descends it turns somewhat on its outer side, whereas
originally it rather lay on its inner side. Thus the vessels come
to lie superiorly and internally to the organ, and as it pursues
its course right onwards the vas deferens is brought into its
ultimate position with relation to it along the posterior and
inner aspect. In the lamb and calf the remains of the
Wolffian body extend from the lobus major of the epididymis
along the depth, and ultimately, its vestiges are seen in
front of the vascular tumor. In the human subject the
hydratids of Morgagni are formed by the atrophy of the Wolffian
bodies. In the female they form the Garruvarium or body of Rosenthal.

Folin believes that in the male there is formed an organ
analogous to the Garruvarium of the female. According to him
the lower part of the Wolffian duct forms the vas aberrans Vallieri
or Robet also describes and the upper part forms the
hydratids of Morgagni; while from the Wolffian body itself
are formed certain diverticular canalici in the Caput
epididymis which communicate with the testis, but
not with the canal of the epididymis and which have a
Clear secretion in which spermatozoa are never found. (Illustration VIII.)

The hydrid of Morgagni he thinks finds its analogue in the female in the pedunculated vesicle frequently found at the fimbricated extremity of the Falloplian tube.

The epididymis gradually becomes convoluted, and at the same time its lower end approaches the extremity of the testicle, and thus a pouch of peritoneum is formed which is the digital fossa.
The Structure of the Submaculum.

The descent of the testicles from the abdomen into the scrotum is a subject on which many authors have written, and that with much diversity of opinion, for more than a century.

John Hunter was the first to describe the structure extending from the testicles in the abdomen to the scrotum, which bears his name—Submaculum Hunteri testis. Unfortunately, this name has been very loosely employed. It has been applied by some to a projection occupying the posterior aspect of the processus vaginalis, and by others to the fibrous structures which reach down to the scrotum.

This confusion has arisen from authors having studied the whole apparatus as a single structure, and some insisting particularly on one part, while others have observed a different part neglected the former. We shall therefore use the word "submaculum" only when we speak of the apparatus generally.

Some have called the mesentery projection just mentioned "Mesorchium (Steile de)"; a name which is more properly confined to the fold attaching the testicles to the abdominal wall, which contains the vessels & vas deferens. The projection is better named "Folliculina Germinalis" (Amold).

At the time when the Wolfian bodies have begun to atrophy, there may be seen very distinctly in the calf & the rabbit (Illustrations III & XIX.), and also in the human subject, though the atrophy occurs at an earlier period,
a peritoneal elevation rasing from the lower end of the testicle, on the surface of the Walfian body, to the junction of the epididymis & ves deferens. It shortens and disappears by the approach of these points to one another, and the adhesion of the inferior extremity of the testicle to the end of the epididymis. A more marked elevation continues the preceding one from the latter point to the groin, and a pit begins to form round the inguinal attachment of this.

So far similar changes are observed in the female. The elevation between the ovary and cornu uteri, corresponding to that between the testicle and commencement of the ves deferens, is the first rudiment of the ligament of the ovary; and a further elevation from the cornu uteri to the groin is the round ligament of the uterus. There is also a pit at the inguinal extremity of the round ligament - the canal of Nuck.

In the male subject the inguinal pit deepens and becomes the lacunae venae bursa vaginalis peritonei, and the elevated fold projects into it from behind in its whole length, constituting the plica gubernaculis. It reaches the bottom of the scrotum in the latter part of intra gestation; and the testicle follows, being situated usually at the internal inguinal opening in the seventh month, in the canal in the eighth, and about the time of birth in the scrotum. According to some authors the passage into the scrotum is only completed by caesare
Bourdon, Principes de Physiologie Comparée, 1830, p. 290

"Hunter on the position of the testicle in the foetus and its descent into the scrotum."
operating after birth. Bourdon asserts that the process is slow in cold and humid countries such as Holland, and that this becomes in such countries a frequent cause of congenital hernia.

Surrounding the processus vaginalis, but stronger behind than in front of it, and reaching from the extremity of that process before it has begun to penetrate the muscular wall, is a fibrous structure attached inferiorly to the skin of the scrotum, and which we shall distinguish as the gubernaculum cord. This has been described by most authors as a bundle of fibres continued upwards in the plica gubernatrix to the testicle. Such is the general nature of the structures whose disputed minutiae we wish to examine in detail. One question which has been particularly agitated with regard to them is, if muscular fibres enter into their composition or not: a question of physiological interest, as it comes to be an inquiry into the agency which draws down the testicle.

Let us in the first place review the opinions held by various writers on the structure of the gubernaculum.

John Hunter, who was the first to describe it and whose name is commonly associated with it, wrote as follows:

"In the foetus the testis is connected in a very particular manner with the parietes of the abdomen, at that place where in adult bodies the spermatic vessels pass out, and likewise with the serous coats. This connection is by means of a substance which runs down from the lower end of the testis to the
serotum, and which at present I shall call the ligament of gubernaculum testis, because it connects the testis with the serotum, and directs its course in its descent. It is of a pyramidal form; its large bulbous head is upwards & fixed to the lower end of the testis and epididymis, and its lower and slender extremity is lost in the cellular membrane of the serotum. The upper part of this ligament is within the abdomen before the pubes, reaching from the testis to the groin, or to where the spermatic vessels begin to pass through the muscles. Here the ligament runs down into the serotum precisely as the spermatic vessels pass down in adult bodies, and is there lost. Huntzli believed the whole apparatus to consist of the ligament described by him, and the process of peritoneum in front of it, to which however he attributed little importance. He believed this ligament to be fibrous in structure, but possessed of contractile properties. Moreover, although he failed to trace the fibres of the cremaster on the surface of this ligament, he thought it probable that they passed upward to the testis and that they helped its transition. He was led to this opinion by analogies drawn from some of the lower animals. But the principal motor agency he attributed to the ligament. Giordi of Parma (according to Brugnori) was the first to observe a number of muscular fibres ascending to the testis. Palleteri afterwards observed them, but doubted if it is early a period they were sufficiently developed to cause the descent of the testis.
*De Pancrea de Testis humanae et abdominis in scrotum descesse. Vienna 1778. Extract in Langenbeck de Structura Peritonei.*


*Bougonni de Testium in petu positio. Memoires de l'Academie de Sciences de Turin 1788.*

*B.S. Seiler, Observations sur les testicules de descente. Leipsic 1817.*
Pancerio ascribes to these muscular fibres more importance. He says that "among the causes drawing down the testicle while it lies high up in the abdomen, the cremaster merits the first consideration, since it ascends in the hollow part of the cylinder at last reaching the impervious part of the cylinder." In the second place he mentions the cellular tissue of the scrotum, which, says he, likewise invades itself into the hollow part of the cylinder.

He thought, as also did Lobstein, that since the cellular tissue has power to corrugate the scrotum, it may also be supposed capable of helping to pull down the testicle. He considered that, having arrived at the external abdominal ring, the further descent of the testicle to the bottom of the scrotum was accomplished by the birth of the child, the commencement of respiration and efforts of abdominal pressure; an opinion held also by Haller and others. The tunica vaginalis he described as formed by the eversion of what he called the cylinder: orig. gliae gubernatrix.

The existence of muscular fibres reflected upwards to the testicle from the internal oblique and transverse abdominal muscles has been confirmed by several writers. Frugoni imputed the descent to their agency, and combated the doubt entertained by Paleotti of their being sufficiently developed, by showing that the other muscles are then capable of action since they produce the movements of the fascia felt by another.

Sailer also describes ascending muscular fibres.
* Bourdon. *Principes de Physiologie Comparée*, 1830, p. 290
description is as follows: "In the region of the abdominal ring, a fold or sheath of peritoneum (mesogastrum genitalis peritonei) rises up, adhesion at the inferior extremity of the testicle with that portion of peritoneum which forms the tunica albuginea. This sheath includes a small conical ligament (Subuomaculum Hunteri), formed of dense cellular tissue, which commence at the apex of the fold or sheath where the inferior extremity of the testicle and epididymis are in contact. At thickness as it descends, it traverses the abdominal ring; and divides into two slender branches, of which one is joined to the cellular tisues that covers the aponeurotic expansion before the abdominal ring, and the other still slenderer mixes itself with the dense cellular tissue toward the symphysis pubis. If we cautiously raise the envelope of peritoneum, we display muscular fibers which curve upwards from the internal oblique and transverse abdominal muscles and cover the cellular onaps and adhere to it; so that the gubernaculum of Hunter seems to be for the greater part a tendinous production of these muscular fibers, for the passage of cellular tisue into membranous membes and tendinous textes is almost indescribable."

He ascribes to the muscular fibers some influence in producing the descent of the testicles, but imputes this chiefly to the development of the parts.

Bordoni gives a similar description of the gubernaculum, but ascribes the descent wholly to muscular action.

The description of M. Robin is of the same sort. It seems to
Cyclopedia of Anatomy & Physiology, article Testicle.

be generally adopted by the French. "The gubernaculum," says he, "presents for study two parts distinct in situation though con-
trasting. The one is placed in the abdomen between the testicle and
the superior orifice of the inguinal canal; the other continues from
the latter point, through the inguinal canal which it fills, to
terminate in three fascicles. The external passes out at the crus of
arch, the second or internal goes in front of the pubis, the third of
median, larger than the others, continues the direction of the muscle
and is lost below in the cellular tissue of the scrotum, as it gradually
gets thinner. This is the only one described by Hunter. Arrived at
the inguinal canal, the organ finishes its descent into the scrotum,
either by the pressure of the viscus or by its own proper weight,
and the muscle is inverted as a muscular pouch."

The description of Mr. Curling is nearly identical with this.
He describes a central soft gelatinous part and an external
muscular part. He adds that these muscular fibres may be
traced the whole way from the ring to the testicle. To make the
views of this set of writers as plain as possible we have copied
Mr. Curling's diagram (Illustration X VII Figs 13 & 2).

Our account has been given by Prof. E. H. Webster of the descent of
the testicle, which coincides with those already mentioned,
in as far as he describes the cremaster as originally directed
upwards, but he attributes only a secondary importance to it,
and regards as the principal agent of the descent the shut
of independent of the spermatic and which he is the
first to describe. "This vesicle," he says, "grows with its upper part into the abdominal cavity, and drags around the lamellae of the peritoneal fold in which the testicle is hung as in a purse, and bears on it muscular fibres which are given off from the internal oblique muscle, upwards to near the inferior extremity of the testis. Hence it is clear that the part called the gubernaculum by Hunter is not a solid cord, but that it is a bladder overlaid with muscular fibres. This under part of the bladder grows downward from the inguinal canal into the scrotum, drags around the cellular tissue, and prepares a way for the testis before that organ has left its place. Thus there exists a large bladder, which is narrowest in the middle where it lies in the inguinal canal, whose upper part projects into the abdominal cavity, is broader and overlaid with muscular fibres which pass upwards from the internal oblique and cover the bladder in oblique and transverse directions; while the under part of the bladder which is still wider is not overlaid with muscle and descends into the scrotum. The descent of the testis is effected thus: the upper part of the bladder with the adhering peritoneum is shoved into the lower part which slaps down into the scrotum, just as you can shove the one half of a might cap into the other." It will be observed that the peculiarity of Weber's view is that he describes a defined sac or bladder, for that the centre of the gubernaculum is hollow or jellyy is his new idea.
Jules Cloquet. Recherche anatomique sur les hernies de l'abdomen.
the elongation of the processus vaginalis as produced by the eversion of the plica gubernaculare; that is to say, that the peritoneum, originally forming the plica gubernaculare, is everted so as to become part of the tunica vaginalis reflexa.

There is another set of authors who entirely deny the formation of the cremaster by fibres originally passing upwards to the testicle in the abdomen, and maintain that it is made by fibres extending from Poupart's ligament to the pubis, which precede the testicle in its descent, as arches on the surface of the processus vaginalis. M. Cloquet has strenuously promulgated this doctrine; and to show how this party, equally with the other, appeal to facts, let us quote a couple of sentences. Speaking of these muscular fibres he writes: "By their middle part they adhere intimately enough to the gubernaculum, and when you come to pull down this prolongation you see them descending with it by the ring, so forming successively the curves of inverted arches which are displayed in order on the testicle and spermatic cord. By pulling the gubernaculum, and simulating thus the natural descent of the testicle, I have succeeded in forming artificially the cremaster; but little content with these experiments, which only represent in a coarse and often very imperfect manner the operations of nature, I have followed the progress of the descent in the growth of this muscle, and I have always obtained the same results."

Carné describes the formation of the cremaster in the same manner. So also does Arnold." In his description of the
gubernaculum he describes like Filletta "a round longitudinal whitish bundle of fibres like the fibres of cellular tissue in structure" stretching from the lower end of the testis to the bottom of the scrotum. Hyrtl gives a similar description.

This eminent observers have differed from one another, and one fears to take upon himself to side with any party while the deliberate statement of others stare him in the face. Yet we hope to make it appear that the accounts of authors are more reconcilable than at first sight they seem, and that the differences of opinion amongst them arise from imperfect, more than from erroneous descriptions.

It is necessary that the structures in question should be studied in the human subject, and that all analogies drawn from the lower animals be kept completely out of view; till we ascertain the answers of the parts themselves to all questions that can be put to them; else such analogies will but lead us into error, and blind us in the study with prejudices. In the first place I shall lay before you my own dissection of the gubernaculum, which have been more measure than could have been wished, on account of the great difficulty of obtaining subjects. I shall then give the results at which I have arrived, and compare them with those of authors; and shall afterwards enquire how far facts bear out the analogies so frequently drawn from comparative anatomy.
Dissection I. My first dissection was made upon a foetus in the fifth month, a preparation which had been long kept. The left groin, on which it was made, had been already interposed with, so that it was necessarily imperfect. It served however to demonstrate two points: viz. that many of the fibres of the gubernaculum cord, descending into the scrotum are connected superiorly with the wall of the abdomen, and that the ilica gubernatricis is independent of that cord. That is to say, that the ilica gubernatricis does not contain a fibrous bundle which runs down to the scrotum and forms the gubernaculum as described by Hunter and others. On the contrary, the processus vaginalis with its ilica gubernatricis seemed connected with the cord by mere cellular tissue.

Dissection II. (Illustration V) This dissection was upon a recent subject about the same age as the former. On removal of the integument of the groin the fascia was found very strong near the scrotum, and with strong fibres inserted into the skin of the scrotum. The inferior part of the aponeurosis of the external oblique muscle was also attached to the scrotum. A defined bundle of fibres issued from the external inguinal ring and was inserted into the lower part of the scrotum overlaid by the internal oblique muscle was the bulbar term-ination of the projection from the peritoneum containing the processus vaginalis. The bundle of fibres above mentioned was inserted superiorly into the abdominal wall, partly
on the external, partly on the internal aspect of the inguinal canal, while a few fibres wraped up between the two sets and were lost on the bulbous projection. No muscular fibres could be detected in this fibrous band by the microscope.

No fibres of the internal oblique were discovered passing upward on the bulbous projection. The muscles were cut across and the processus vaginalis laid open. The processus vaginalis did not penetrate the whole length of the projection which contained it, but the bulbous extremity of the latter was formed of tissue exterior to it. The knife being carried through this the appearance of a blast sac was detected in its substance which seemed to run up into the falciform gynecomatrix; but under a powerful lens the appearance was not such as to warrant the supposition that it was a serous cavity. This is doubtless what has been described as a blast sac by Weber, and to which he attributes an important a function.

**Deflection III** (Illustration VII) This deflection was made on the untouched side of the subject on which deflection 1st had been made. On removal of the integument and fascia the aponeurosis of the external oblique muscle was observed descending to the bottom of the section. The fibres so descending had chiefly a superficial origin from the outer end of Poupart's ligament. They seemed to form several bundles, one of which was much firmer than the others. This one for the most part, and some other fibres passed through.
the aponeurosis of the external oblique upwards toward the tubercle.

In the subsequent dissection the internal oblique muscle was cut vertically across, and the processus vaginalis laid open. The peritoneum forming the process was found to consist of two layers— an external or cellular, and the serous layer or true membrane. The serous layer descended for less than half the distance of the tube from the internal oblique muscle. The cellular layer which was quite distinct from the serous layer toward the groin, passed down to the level of the external oblique, and was lost in the bundles already mentioned as passing upwards. Some fibres of the internal oblique on the outer side of the gubernaculum passed downwards upon it: some were connected with it as they crossed in front of it from the outer part of Poupart's ligament to the pubis, and the muscularity of these fibres was tested by the microscope. On the inner side of the gubernaculum apparatus a distinct and well-developed layer of fibres was observed passing upwards from the internal oblique, internal to and behind the gubernaculum, and inserted on the superficial surface of the cellular layer of peritoneum. These fibres were shown under the microscope to be striped muscular fibres.

Within the enclosure formed by the prolongation of the cellular layer of peritoneum were a number of bands of cellular tissue more or less fibrous. One band was clearly adherent to the peritoneal free prolongation, and passed up and was lost opposite the neck of the tube. The rest occupied the cavity, and passed up to the com-
mencement of the vas deferens and cellular layer of peritoneum, and to the lower extremity of the testis, and the serous layer, connected with these was a map of cellular tissue depending from the lower end of the testis, which occupied the pleura gubernatrix. No muscular fibres were found within the middle of the cellular layer of peritoneum.

Section IV. (Illustration XXII) This description was made on a fetus of the fourth month which had been long kept. All the textures in this fetus were excessively hardened. On removing the integument from the right side, the fascia was displayed; and toward the scrotum, a bundle of deeper fibres seemed to penetrate it, to be inserted in the skin. This fascia and the external oblique muscle were turned down, which displayed the internal oblique muscle and the gubernaculum cord running down through the aponeurosis of the external oblique and the fascia, from both which it got additions. A bundle of fibres of the internal oblique muscle passed down on the external aspect of the gubernaculum. The internal oblique muscle was turned to the inner side, and the peritoneum slit down to the bottom of the processus vaginalis. The pouch of the processus vaginalis extended to a little above the level of the internal oblique muscle; but superficial to it was a cellular layer separable from the serous layer of peritoneum, which formed a prolongation downwards beyond the process and became incorporated with the gubernaculum cord. On the superficial surface of this prolongation were reddish bands running upwards like muscle.
which however under the microscope proved mere areolar tissue.
The edge of the internal oblique muscle was connected with a fascia
joining these bands, but no as ending muscular fibres could be
detected under the microscope.

Dissection V. (Illustration VIII-IX) This dissection
was made on a recent subject, a fetus of the sixth month; on
the left side. The testicle was still within the abdomen, just
at the mouth of the processus vaginalis. On removing the integu-
embranous from the inguinal region, the stout inguinal fascia was
displayed, its fibres running downwards and inwards to be
attached in the fibrous texture occupying the scrotum. A
firm bundle however, consisting superficially of fibres from
the fascia but enclosing others, was firmly attached to the skin
on the outer aspect of the scrotum. On turning down the
fascia and the lower part of the aponeurosis of the external oblique
muscle to the scrotum, the aponeurosis at its inguinal attachment
was seen to be much connected with the fascia. The gubernacular
cord was seen piercing it and joining the fascial bundle already
mentioned. Fibres from the external oblique aponeurosis passed
upwards on the gubernacular cord. A marked bundle of fibres
of the internal oblique muscle passed downward externally to
the gubernaculum to be inserted into the pubis; and a number
of fibres, whose muscularity was proved by the anterior cove, arched
downwards upon the surface of the gubernaculum.

The conjoint part of the internal oblique and transversalis
was divided vertically and turned to the two sides, and was then found to be connected with the transversalis fascia, and to send fibres upwards in it on the surface of the gubernaculum. The transversalis fascia was easily separated from the gubernaculum. Cutting open the gubernaculum itself, it was seen to consist in the first place of a layer of fibrous membrane, first above, in the peritoneum, but forming a distinct and dense textured pouch below, whose cavity reached down to the level of the external inguinal ring. Pushing its way downward into this pouch was the bulbous extremity of the projection containing the processus vaginalis. This reached only as far as the border of the internal oblique muscle, and was attached to the walls of the pouch by some cellular tissue. The peritoneum, composing it, was so thick that it admitted of being separated into layers, and the one superficial layer could be detached from the others, so as to expose the fibrocellular matter which had projected into the pelvic perimetrium. That it was nothing more than fibrocellular matter was proved by the microscope. It was lost below in the intermediate layers of peritoneum.

Dissection VI. (Illustrations X & XI) This dissection was made on the right side of the same foetus as the previous dissection. The descent as will be seen was further advanced on this side than on the other, a circumstance interesting as a departure from symmetry, and illustrating the variability of the period at which the descent is accomplished.
The testicle had just disappeared from the abdomen into the processus vaginalis. On removal of the integument & dissection of the fascia down to the ventral region, the fascia was found much connected with the external oblique aponeurosis, and this connection was so engrossed around the external inguinal ring that a sort of pouch was formed, in which lay the bulbous extremity of the gubernaculum, only attached to the walls of the pouch by cellular tissue, more or less dense at different places.

On turning the external oblique muscle down to the 3rd layer, the internal oblique was seen hugging over the gubernaculum, and sending fibres arched downwards on the surface of the same. The fibres of the internal oblique were then cut vertically a few to the transversalis fascia and the processus vaginalis. The processus vaginalis reached to the bottom of the bulb of the gubernaculum. Its walls, which with the plica gubernaculi formed the whole existing gubernaculum, were composed of thickened peritoneum capable of being divided into layers, and the second or true layer separable from the others & from the fibro-cellular substance occurring the plica gubernaculi. Some cellular fibres from the internal oblique were inclined upwards in the transversalis fascia.

Such are the dissections which as yet I have had the opportunity of making of the descent of the testicles in the human subject; and I have recounted them thus minutely to show candidly my authority for the conclusions which I draw. Let us now sum up briefly the points which they indicate.
In the first place, they show that there is no simple ligament running directly from the testicle to the scrotum, but that the fibrous tissue of the gubernaculum is composed of a superficial fibrous layer of peritoneum and the fibrous tissue within the same, which occupies the plica gubernatrix, of ascending and descending fibres from the aponeurosis of the external oblique muscle and of ascending and descending fibres from the fascia of the groin.

In the second place, they show that there is no permanent definite sac such as described by Weber, but that there is a sac-like space left in the first instance between the serous and fibrous layers of peritoneum, afterward between the different fibrous layers, and lastly between the fascia on the one hand and the gubernaculum as made up of all the peritoneal structures on the other.

Thirdly: the dissections confirm the existence of the cremasteric fibres arched downwards upon the gubernaculum as described by Cloquet, and also on the other hand confirm the existence of an ascending set of muscular fibres so strongly upheld by so many authors; but this latter set do not occupy the position which authors have assigned them, namely within the plica gubernatrix.

On these three subjects we shall make remarks separately.

As regards the first point,—the direction of the fibres entering into the structure of the gubernaculum, our observation that there is no simple ligament, such as has been often described running directly from the testicle to the scrotum, is not a mere denial...
meaning only that we have been unable to see it, and which might be translated as indicating no more than that it had been destroyed in making the dissection, or had not been looked for in the proper way, but the structures which do exist are different from the descriptions which speak of such a ligament, and incompatible with its existence. The presence of such a ligament is quite inconsistent with the anatomy displayed in dissections T & VT, in which the extremities of the bulks containing the processus vaginalis were found to lie free in a pouch, in the fascia in the latter case, and in the outer layer of the gubernaculum fibres in the other.

With reference to the manner in which fibres of the gubernaculum are derived from the various layers of the abdominal wall, it is worthy of remark that a similar arrangement occurs in the round ligament of the female. Witness the following description of a female fetus of the fifth month.

(Illustration XII) The left round ligament was detached from the oviduct, and traced upwards through the muscles of the abdominal wall. A number of aponeurotic fibres were inserted in the labium. A great part of these belonged entirely to the aponeurosis of the external oblique muscle, and ran upwards and outwards into that muscle; but some fibres pierced the aponeurosis of the external oblique, and, with other fibres which they received thence, proceeded upwards and pierced the internal oblique and transversalis muscles. A large number of fibres were reflected from these muscles.
and helped upwards sheathing the ligament. The ligament thine increased terminated in part in the transversalis fascia, but for the most part turned inwards, and formed the round ligament as it may be seen from the peritoneal aspect. On further digestion it appeared that all the fibres from the internal oblique and transversalis muscles terminated in the peritoneum, but the main cord passed on to the uterus, & its fibres became incor = porated with those of the uterus.

It will be observed how similar is the disposition here, not only of the fibrous tissues but also of the muscular, to that found in the male.

In the next place we have to consider Weber's sac. That there are pouches of a certain sort in the gubernaculum, although not so vast, we have seen. But Weber seems to us to be mistaken in two points. The first is that he supposes that the sac-like cavity, extends into the plica gubernatrix; and the other that there is only one such sac, which is a defined bladder and undergoes mod = ification of form in the descent. Here we find that although the plica gubernatrix is occupied by a gelatinous-looking substance, this substance is a fibrocellular tissue, not a gelatinous fluid. And although it is in close connection with the sac-like expansion in the fifth month, at a more advanced period it is separated from the latter by very strong tissue.

We think that instead of this sac of Weber's being a defined structure such as he describes, we have only to do with spaces in the tissue, and
that there is a series of these formed as the processus vaginalis descends. Thus the space exhibited in dissection II is not the same as that of dissection I, nor that of dissection V. The same as that of dissection I. It seems to us (although we have had no opportunity of dissecting a foetus quite young enough to demonstrate it) that the first condition of the gubernaculum must be as a cord formed above from the external surface of the peritoneum and some fibres issuing from the pleuric gubernaculum, and that it gives and receives fibres in the various layers of the abdominal wall until it reaches its inferior attachment at the vertebra. The foetus on which dissection II was performed was a little more advanced. It displays a processus vaginalis of some depth. And now the fibres from the external layer of peritoneum begins to be developed in two directions, some clinging to the processus vaginalis, and some following the direction of the gubernaculum cord. As the process advances however the first set are the principal and ultimately the only ones which are developed; and have a gradually thickening bulbous extremity, which push its way down the centre of the gubernaculum cord, where fibres are separated before it forming a kind of funnel shaped cavity, and at last, when the processus vaginalis has finished its journey, are quite incorporated with the neighbouring tissues.

The third subject suggested by our dissections is the formation of the cremaster muscles. It looks strange that while so many authors have described the cremaster as originally
Pajing up to the tellotile, and others have strenuously maintained that it is formed by loops upon the Processus vaginalis as it descends, none of the accounts hitherto given have even suggested the possibility of there being two sets of fibres. Yet it would be hard to say of the observers who express either of the two fibres that they have not seen those things which they so particularly describe. It is therefore with satisfaction that we find sets of fibres corresponding to both descriptions. The ascending fibres are described by Weber as covering the superior part of this sac in transverse and oblique directions, and by Teller, Robin, Frilip etc., as ascending to the testicle and covered like it with peritoneum. They are not however in reality attached to the testicle nor do they ascend in the Plica gubernatrix. Such an arrangement is incompatible with the structure of the gubernaculum as it has just been described.

The contents of the Plica gubernatrix are within the whole thickness of the superficial layers of peritoneum, which we have spoken of, whereas the fibres from the internal oblique muscles are necessarily superficial to these and keep upwards on their surface.

The lower set of fibres descending on the front of the gubernaculum are well figured in M. Cloquet's book, whose figure we have copied (Illustration XVII. 3) It seems to us that it is chiefly or rather entirely from them that the adult cremaster is formed.

As for the ascending fibres we believe them to be atrophied, for they are much more evident in dissection than in animation.
Gazette des Hôpitaux 1849
while in dissection V they
could scarcely be said to exist.
If they underwent the sort of
question ascribed to them to bring
them into the ultimate position of the
cremaster, that process would of
necessity have begun long before the
procesus vaginalis had reached the
point which it has in dissection V, and it is im-
possible that fibres occupying at that period the
position which we have represented there in,
could ever extend to the bottom
of the scrotum. Besides there is
the difficulty of supposing their
insertions being subjected to the
extremely taut position which would be
necessary. Thus let Fig. 1 represent the original position of the fibres,
if this event took place they must ultimately occupy the position
shown in Fig. 2. But we shall presently have occasion to return
to the subject of this question.

It is principally with regard to the origin of the cremaster
that comparative anatomy has been appealed to in the subject
of the descent of the testis. John Hunter puts great importance
on the upward direction of the cremaster in trees in which the
testicles had been retained in the abdomen; Mr. Robin also in 1849
exhibited to the Societé Biologique a muscular gubernaculum
in a dog in which the same thing had happened. It is to be
remembered however that such observations have only a limited
value in the discussion; that arguments drawn from them are
mere arguments of analogy, and therefore can only give probability
not certainty to any view. The disposition just alluded to in
this dog and ram are sufficient, apart from other evidence for and
against, to make it seem probable that in the human subject there
are likewise fibers ascending towards the testicle while yet in the
abdomen, but that is all.
What Hunter says is this: "In the ram when the testis is come
down into the scrotum the cremaster is a very strong muscle,
and though it is placed more inwards at its beginning, it keeps
down pretty much as it does in the human body and is lost on
the outside of the tunica vaginalis; but in the ram when testis still
remains suspended in the abdominal cavity I find that the cre=
master still exists, although it is a weaker muscle, and instead
of passing down as in the former case, it turns inwards and upwards
and is lost in the peritoneum that covers the ligament which
attaches the testis to the pancreas of the abdomen, which in this
state of the animal is about an inch and a half in length. In
the human fetus while the testis is retained in the cavity of the
abdomen the cremaster is so slender that I cannot trace it
to my own satisfaction either turning up toward the testis or
downward toward the scrotum. Yet from analogy we may conclude
that it passes up to the testis, since in the adult we find it inserted
or lost in the lower part of the tunica vaginalis in the same
manner as in the adult quadruped."
Now in the first place, the anatomy of the cremaster in the
human subject varies considerably in different bodies. In some
instances it is composed of very distinct loops, in others the fibres are mostly, if altogether lost in the fascia inferiorly. This latter appearance seems to be sometimes occasioned by loops whose fibres split up and are spread out at the inferior part, but in other cases it results from definite bundles which continue well pronounced in their whole length, and appear to be attached in the fascia inguinale below. To illustrate this we have copied a sketch from M. Clagett of a cremaster formed by distinct loops (Illustration XVII). We have also given sketches of the cremasters of a new born child in which the fibres are distributed differently. The looped fibres are undoubtedly formed on the descending half of the gubernaculum. Hunter's description however ignores these fibres altogether, and represents the human cremaster as similar to the ramis, which is indeed, as he describes it, "a very strong muscle whichobia down and is inserted on the outside of the tunica vaginalis."

In the second place the anatomy of the testis seen in which the testes do descend is at variance with the notion of muscular fibres ascending to the testis itself. In both the calf and the lamb the Jilica gubernaculatrix is a very large structure much larger than in man, and in the former projects so much from the wall of the processus vaginalis as to be folded in upon itself. This Jilica gubernaculatrix is filled with gelatinous looking substance, and increases in bulk until its extremity has reached the bottom of the scrotum.
At that time the cremaster may be seen occupying its ultimate position, stretching down to the lower part of the tunica vaginalis. The testis has still the whole length of the flesca gubernatrix to traverse, and they are no muscular fibres in the flesca, nor indeed can there be, for it is formed as in the human subject in the thickness of the peritoneum, being a fold of the serous layer and bounded behind and thoroughly separated from the superficial structures by a thin external layer. It is quite evident therefore that it is not the cremaster which pulls down the testis in these animals. And if the cremaster ever had in them an upward direction it must have been before the flesca vaginalis reached the inguinal ring. But in these animals that is an event which happens at a very early period. In a fœtal lamb between three and four inches long, when the muscles of the abdominal wall were nearly recognisable, the bulb of the gubernaculum already projected a long way beyond the external abdominal ring. There is only one explanation we can think of to account for the muscular fibres observed by Hunter ascending to the testis in rams in which that organ remained in the abdomen. It is, that the flesca gubernatrix had been arrested in its earliest stage while yet entirely in the abdomen, and before the appearance of a flesca vaginalis and that the fibres of the cremaster were directed, as usual to its extremity, the point which ought to have been at the bottom of a flesca vaginalis, and thus there
would be an anatomy similar to what we shall shortly have occasion to notice in the fetal rabbit.

The anatomy of the hedgehog is also appealed to by Hunter in evidence of the ascending origin of the cremaster, and it is still referred to, to illustrate their views, by those who follow his opinion and who think that the tunica vaginalis is lengthened by the eversion of the iliac gubernaculum as one turns the fingers of a glove. There is however no argument to be drawn from it at all.

When the hedgehog is inspected with the testes drawn down beyond the abdominal ring, its cremaster is seen to be not essentially different from that of the human subject; but it is stronger and presents a beautiful example of a cremaster formed entirely of loops. (Illustration XIII & XIV). Hunter appears to have thought, as well as some of the writers after him, that the testes of the hedgehog were always in the abdomen, and if this had been the case it would of course have made the argument a far more urgent one. But since they are in reality extruded at set times from the abdomen, the question comes to be—what is the rightful position (so to speak) of the testes in animals in which they descend periodically? Is their high position the result of a mere deviation for functional purposes from the original site to which they have a morphological inclination in virtue of the animals being Mammal & because that is the general adult position in mammals? Or is the high position the morphological one, because it is the site of development and is the usual one in vertebrata generally?
is the extraction so mere functional incident? We have had no means of determining this upon the hedgehog, but from the fetal condition in another animal in whom there is a periodic descent we find reason to believe that the position external to the abdominal cavity is the rightful one, and that within the cavity adventitious in the adult, and we think we shall be justified in considering the same thing to hold good in all animals of this description. In a fetal liveret near birth the processus vaginalis is projected downwards from the abdomen, and the testis hung in it beyond the external vaginal ring just as in animals in whom the descent is permanent. It is quite evident that if the intra-abdominal were the proper position of the testis in these animals, and the external one a departure from the normal state assumed at times for mere functional exigences, we should find no inclination to the latter till the commencement of puberty; but the gradual assumption of this position in the fetus associates these animals with those in whom the descent is permanent. Now if the testes of the hedgehog morphologically occupied the abdominal site in the adult animal, it might be considered as offering an example of an ascending cremaster or muscular gubernaculum as Hunter called it; but since there is reason to believe that such is not the case, there is nothing whatever in the anatomy of its cremaster from which to argue the possibility of such a structure in the human embryo. The cremaster must be considered as essentially similar to that of the human
subject, though incidentally kept usually drawn up into the abdomen. As to its function: it probably indeed acts as a gubernaculum to bring down the testes to the external abdominal ring when above it, but it is equally adapted for compressing that organ or elevating it when it is outside the ring.

The cremasters of the quadruped are referred to by a number of authors, and among others Weber appeals to the anatomy of these animals in support of his peculiar views. In no class of animals, he says, is the process of the descent better observed than in the quadruped, e.g. the hare and rabbit but especially the beaver. Of these let us take the rabbit for an example. What has just been said of the hedgehog, as to the improbability of considering it as presenting an example of an ascending cremaster in the adult condition, applies equally here. Neither can the cylindrical space formed by the inversion of the cremaster be considered as a sac, nor can any analogy be drawn from it to support the idea of such a sac as Weber describes in the human subject. We have here no real sac-like structure, but only the space in the cellular tissue which must result of mechanical necessity from pulling the processus vaginalis outside in and forming a fold where there had been a projection. In structure and development the cremaster of the rabbit is altogether different from the human cremaster. (Illustration XV) It is composed of two distinct sets of fibres, besides some fibres of the external oblique which are lost on the front of the pouch of the testes.
One set is continuous with the internal oblique muscle, whose fibres arising from Poupart's ligament and the pubic raphe upwards and downwards on the pouch of the testis. The fibres from the pubis are strongest and form down on the posterior aspect of the pouch. The other set of fibres diverge from a vertical line on the back of the pouch and embrace it, some passing upwards and inwards, some upwards and outwards so as to make a hemiform muscle. This set is deficient above. A band of the inner fibres joins a band from the cremaster of the other side in front of the pubis, and with some fibrous tissue forms a commissure. The action of the longitudinal fibres will draw the proceps vaginalis to the inguinal ring, and the circular ones will either push the testis into the bottom of the proceps vaginalis or extend it from it according to its position and whether the superior or inferior fibres act. If the testis be beyond the abdominal ring and the walls of the abdomen and the cremaster all contracted, the testis will be powerfully compressed. Thus the cremaster is as much adapted for the ordinary function of cremaster as for a graber-vacuolar action.

In a fetal rabbit between two and three inches long, (Illustration XIX, Fig. 2) the external oblique aponeurosis passed down over the inguinal ring like a ligament to the side of the penis. On removal of this the internal oblique was seen to be reflected upwards, except at the outer side, in a hollow cylinder which reached some little distance and was continued by an impression: Silia gularis intract
to the testicles. The ligaments on the outer side continued their course downwards with some fibers passing from the inguinal ring. This account is sufficient to show how greatly the anatomy of the descent differs in the rabbit from that of the human subject. But there is another point in which the descent in the human subject has been compared with what occurs in the adult rabbit; viz, in the supposed prolongation of the processus vaginalis by eversion.

This brings us to the next topic which we propose taking up, the manner in which the processus vaginalis is prolonged. It has generally been believed by those who have held the opinion of the cremaster ascending to the testis, that the processus vaginalis is lengthened by the eversion of the fleshy gubernaculum, just as the finger of a glove turned in upon itself is pushed out again. By this eversion they account at the same time for the prolongation of the process and for the testis reaching the bottom of it. If, however, the anatomy of the parts is such as has been said above, the temptation to this theory entirely disappears. If the fleshy gubernaculum only involves the innermost layer of peritoneum such an eversion of the fleshy and elongation of the processus vaginalis becomes impossible. Independently of this and supposing the facts to be as these authors describe them, it is by no means so easy to conceive of the eversion in the human testes as in the rabbit. In the latter the testis is attached by a very broad mesorchium, so that the operation can take place quite simply as they describe, and the mesorchium alone has to accommodate itself to the change.
But in the human subject the mesorchium is quite short, and the testicle adheres to the posterior wall of the processus vaginalis, so that the only sort of eversion which could take place would be as follows. The peritoneum a covering the testicle would travel to c without any growth of the peritoneum which lies between a and b, whereas the peritoneum between a & c would have to lengthen itself to such an extent as to fill the whole space from c to a. Thus the proceeding would be very different from what is seen periodically in the Chordons. If, as we wish to show, the flicia disappears not by eversion but by contraction, there is still necessity for a growth behind which is not required in front, but to a less extent, namely from c to d, and only in the track of the contracting flicia. The puckering in the peritoneum, as observed in the calf when the testicle reaches its destination, correspond with what is to be expected from this contraction; that is to say, they are directed from the lower end of the flicia, spreading upwards on each side of it. Moreover as the testicle descends, the flicia, formerly flump and full, assumes a shrivelled appearance as of a body undergoing atrophy.

There is little left to say at this stage of our subject on the causes operating to bring down the testicles.
*Mentioned here on the authority of Deiler.*
it is only at an early stage, and by means of the fibres which we have described ascending on the surface of the gubernaculum. Perhaps these fibres have their existence as much as analogues of the fibres which ascend in like manner on the round ligament of the female, as for aiding in the descent, just as the canal of the neck seems to exist in the female rather as the analogue of the processus vaginalis in the male than for any important function, or as the sinus procularis appears to be present in the male merely as the analogue of the uterus. That muscular agency has little to do with the matter seems indicated by the presence of such well marked ascending muscles as are mentioned by Hunter and Rokitansky in cases of retention of the testis in the ram and dog, else we should have expected an account of some evident mechanical cause of retention, against which a muscle unusually developed for the occasion hardly failed. The descent of the testis to this position seems to be in virtue of a natural rule of growth, just as the same way as the previous descent from below the kidneys to the internal abdominal ring. It is marked by the atrophy of the ilica gubernaculis in front of the descending organ, and growth of the peritoneum behind it; but that the ilica or other structure of the gubernaculum exercise a mechanical effect in pulling it down, there is no reason to suppose. Pancrea and Sobotta attributed some influence to the cellular tissue of the scrotum and the former considered as did also Haller and Roth, that
the expulsion through the abdominal ring was only accom-
plished at birth by the compression then exerted on the child, by
commencing respiration, and by abdominal pressure. This
however was an error, as it is quite certain that the testes
usually reach the scrotum before birth.

In conclusion, to sum up:—The gubernaculum consists
of two essentially distinct parts; firstly, the structures descend-
ing in front of the testis, viz. the Proctus vaginalis and its Gilia
gubernaculis; and secondly, a fusion of parts forming the wall
of the abdomen—fibres passing downwards from the peritoneum,
upwards and downwards from the aponeurosis of the external
oblique, upwards from the fascia and skin, and fibres ascending
on the surface of these from the conjoint portion of the internal
oblique and transverseus muscles. The first portion makes
its way down through the second, and scatters it; and after-
wards as the Gilia gubernaculis contracts, the testicles
reach the bottom of the scrotum.
Inquiry into the Object of the Testicles' Descent.

No one can study the structures which we have been considering without the question frequently recurring to him,—for what purpose is all this? What is the object of this descent of the testis, for which so many complicated provisions have been prepared? And if we turn our eyes to pathology and observe how many males are favored by it, then on the one hand it weakens the abdominal wall, forming the most frequent passage for hernia; and on the other hand exposes the testis itself and its coverings to injury, and thus multiplies the causes of orchitis, and opens the way for hydrocele and scrotal diseases. We must feel sure that the object gained is an important one; and this even although experience has shown that the retention of the testes in the abdomen is quite compatible with virility. This latter circumstance only makes the matter look more inexplicable. So unaccountable indeed has it seemed to be, that not a shadow of an explanation appears to have been offered by anyone on the subject, save the general statement that the pendulous position favors the flow of blood to the testis, and that an abundant supply of slowly moving blood is required in an organ whose secretion is so elaborate. In daring to make a few remarks on a subject on which so little is written, we only come forward to enquire the facts at our disposal, and see what can be arrived at by their aid.
It is to be remarked that the normal position of the testes in the vertebrata is within the abdomen. In fishes, reptiles, and birds they are so placed, and in some mammals—man is the only animal in which they are completely separated from the abdominal cavity, and in him this peculiarity is sufficiently accounted for by his erect posture. In all mammals they are originally developed in the abdomen, and in the females of those species in which they descend, the corresponding organ—the ovary—remains in the abdomen through life. It is plain therefore that the explanation of the descent is not to be sought in morphological but in functional considerations.

The principal functional peculiarities of the testicle are these:—its secretion is the most complicated secretion of the body in structure, development, and function, and has the greatest length of tube to travel. It is discharged immediately whenever it is demanded by a reflex action induced by the will, always discharged then and only then, although these summonses are at capricious intervals.

Let us now look at the anatomical peculiarities of the testicle. Besides its pendent position, for which we seek an explanation we have to notice that it is the most complicated gland in the body; that notwithstanding the manner in which its secretion is expelled, there is no reservoir for its accumulation; that it is contained in a space limited by an unusually dense capsule—the tunica albuginea; and that it is surrounded by contractile
structures: viz., the cremaster and ductus capable of elevating it and also of compressing it, especially when the abdominal muscles are contracted so as to offer a firm resistance to it when pressed against them; and thirdly, the organic muscular coat described by Köllicker, which is calculated particularly to compress the vessels. It is also supplied with very remarkable blood vessels. The artery has a very long course before reaching the organ; it is destined to supply, and an extraordinary circumstance is that it increases in diameter as it proceeds. In addition to this, it is usually much convoluted, just in the trunk at least in the ramifications. In the bull and ram the convolution of the arterial trunk is carried to such an extent that it forms a lateral tumor like a coiled rope on the anterior extremity of the testis. And in these animals we may notice that the testes are likewise very large, very anility, tubulated, and very pendulous. In the hare the spermatic artery splits up into several branches before reaching the testis, all larger than the parent trunk. The spermatic veins are large, feathery and numerous. They are so much so in the human subject that they are called vesal spermaticorum, and are from the same cause, particularly inclined to varix.

The abundance and tortuosity of the veins and the increasing diameter of the artery give, as Mr. Wollaston has indicated, a slow and plentiful supply of blood, and protect the organ from sudden violence of the circulation. Were it not for the pendent position, the enlarged artery
would be always half empty, but with that position it follows
that it is always full. The circulation is made slower by the
various inclinations and imperfect values of the veins, which must
tend to produce an accumulation in their lower part, so that the testis
will be kept in a slow-moving bath of blood.

In addition let us take into consideration the dense nature of the
tunica albuginea, with difficulty admitting of any distention. It
is evident that its cavity will only admit of a certain amount
of fluid in it at a time, so that if when the testicles are empty it
is filled with blood by its pendent position, the bloodvessels must
in turn be comparatively empty when the seminal testicles are full.

This circumstance seems to furnish the key both to the
functional and anatomical peculiarities which have been enumerated.

In the first place it influences the secretion. When the
testicles are empty the blood vessels will be distended, and
consequently the glands will be in the most favorable circum-
stances for generating secretion. If it as the testicles fill,
the blood will be forced out of the cavity of the tunica albuginea,
till when they are full the vessels will be empty, and thus
instead of the secretion still going on to as to overflow the gland,
secrets will be dispersed in the manner best fitted to promote
absorption. By this means in the healthy state an equilibrium
is effected, and the testicle is kept filled with fresh secretion
but not overflowing.

In the second place, the same circumstances of the cavity
of the tunica albuginea affording only a limited accommodation for fluid aids the process of expulsion. When the dartos, cremaster, abdominal wall, and Kölliker's muscular tunic are all contracted, not only must the general bulk of the testis sustain considerable pressure, but the veins in particular must be compressed. In consequence of this, as the blood is propelled into the capsule of the organ and finds no exit, it distends the vesicles and expels the contents of the tubules from the cavity of the capsule. By this means, immediately on being evacuated, the gland is left in the condition most favorable for its restoration.

If these views are correct, there is afforded an explanation of the recurrent position and peculiar bloodvessels of the testis, and of how the secretion is kept in readiness without overflow, and is expeditiously expelled without the help of a reser voir.

There are some animals which present exceptions to the general mammalian rule of the descent of the testis, and it is difficult to say why they do so. It may be remarked that they are generally large animals and are only in heat at long intervals. Such are the Elephant, Rhinoceros, Cetacea, etc. In the monotremata likewise the testes remain in the abdomen, but in their case this is only one of the many points in which these animals differ from the generality of Mammalia. A circumstance which struck Linnaeus is worthy of notice. The vasa deferentia, he writes
"...have usually walls firm and thick, generally of an equal diameter throughout their whole extent, and a direct route, without inflexions, except those necessary for arriving at their destination. But in all these respects there are found remarkable exceptions, their walls have seemed to us much less thick and less consistent; in the animals whose testicles never leave the abdomen, such as the antelopes, the echidna, the elephant, the rhinoceros, and the dolphins, than in those which have these organs constantly or momentarily outside the same cavity. In the first case they have besides a course extremely flexuous in part of their extent, those of the elephant for example form a very great number of sinuositites and inflexions in the part which passes along the superior aspect of the bladder to its neck. Those of the echidna continue very flexuous till near the place where they commence, and where the epididymis ends. They are indeed less flexuous in the dolphins, this disposition is still found known very remarkably in them. They are found equally flexuous in the human and antelopes." The comparative thickness of the walls of the vesicula deferens in these animals is explainable by taking into consideration that the circumstance here no longer exists which calls for a tube of the firm cartilaginous consistency found in animals with the testicles pendent. The induration of the tube in these latter is to support in its ascent a perpendicular column of fluid, but in the former the column ceases to be perpendicular. The convolutions of the vesiculae would seem...
to show that the greater part of the secretion expelled had previously gathered in it.

The animals in which the descent is only temporary are of a very different description—the chirodentic bats, hedgehogs, etc. They are mostly animals prolific and with the tested comparing large. Perhaps the object is to secure more perfect secrete for these organs between the frequent nuts. Their functional activity is intermittent to compensate perhaps for its being, when they are in action, so great as is indicated by their large volume.
Explanation of Illustrations.

II. Fig. 1. Appearance of the germ preparing organ in the calf before there is any appreciable sexual distinction. a Urachus between the hypogastric arteries. b-b Wolfian bodies. c-c Ducts of Wolfian bodies. d-d Germ preparing organs. (testes or ovaries).

Fig. 2. Testes of the calf when the Wolfian bodies have begun to diminish. a-a Kidneys. b-b Suprarenal capsules. c-c Testes. d-d Wolfian bodies. e-e Portion of the Wolfian body turned open to show the dilatation like Malsphian capsule. f-f Müllerian ducts ending in tubular mazes g-g. h-h Ducts of the Wolfian bodies. i-i Commencing spermatogenesis. k-k Uterus. l-l Hymen.

III. Testes of the calf when the Wolfian bodies have become atrophied. a Urachus between the hypogastric arteries. b-b Testes. c-c Point of junction of epididymis and vas deferens. d-d Mazes composing the coni vasculosi; the left side shows some of the individual tubes joining the epididymis. f-f Abdominal cord joining the testis and coni vasculosi, and becoming split into the vas afferentes. g-g Remains of the Wolfian bodies. h-h Spermatic arteries. i-i Upper portion of the plica gubernaculatrix between the testis and epididymis. k-k Main part of the plica gubernaculatrix occupying the processus vaginalis, which is slit up to show it.

III. Fig. 1. Ovary of the calf when the Wolfian body has begun to diminish. a Urachus. b-b Wolfian body. c-c Ovary. d-d Müllerian duct. e-e Maze containing the distal extremity of the Müllerian duct and strick to form the fimbriae. f-f Common portion of the Müllerian ducts which forms the cervix uteri. g-g Ducts of the Wolfian bodies.
Fig. 2. Ovaries of the calf when the Wolffian bodies have become atrophied. 

Fig. 1. Ovaries of a human fetus during the fifth month. 

V. Dissection III of the description.


g. Fibres from the same bundle which ascend to the bulbous process which contains the processus vaginalis. h. Internal oblique muscle. i. Aponeurosis of the external oblique muscle. k. Integument reflected down.

VII. Dissection III of the description.

a. Testis. b. The serous visceral layer of peritoneum reflected over the testis. c. Superficial layer of peritoneum. d. Fibres ascending in the process formed by this superficial layer. e. Plica gubernaculata.

f. Junction of the epididymis and vas deferens. g. Bladder cut away. h. Internal oblique and transversus muscles cut and turned aside. i. Muscular fibres according to be inserted in the superficial layer of peritoneum. k. External oblique aponeurosis.
VIII. Dissection IV of the description. a. Testis.
3. Epididymis. c. Vestige of the Wolfian body forming the hydatid of Morgagni and probably also the orca abdominis Halleri.
4. Plèca gubernativa. e. Superficial layer of peritoneum with radiating fibres on its surface. f. Conjoined part of the internal oblique and transversalis muscle.

VIII. Dissection IV of the description. Superficial stage of the dissection exhibiting the medial attachment of the gubernaculum cord and the fibres which it derives from the fascia.

IX. Dissection V of the description. Deep stage.
a. Testis. b. Serosa or true layer of peritoneum forming the processus vaginalis separated from the adjoining tissue.
c. d. Superficial fibrous layer of peritoneum. e. Tissue occupying the plèca gubernativa, with a bristle under it. f. Pouch-like cavity between the layers of peritoneum. g. Fascia transversalis. h. Transversalis muscle.
i. Internal oblique muscle. k. Aponeurosis of the external oblique muscle. l. Integument.
m. n. Conjoined portion of the internal oblique and transversalis cut across and reflected.
22. Muscular fibres ascending on the gubernaculum. q. Looped muscular fibres on the front of the gubernaculum.

X. Dissection VI of the description. Superficial stage.
XI. Dissection VII of the description. Deep stage.

a. Testis.
b. Serous true layer of peritoneum separated from the adjoining parts.
c. d. Superficial fibrous layers of peritoneum.
e. Tissue which occupied the plica pubocervicalis. 
f. f. Conjoined part of the internal oblique and transversalis muscles continued into the cremaster. 
g. Aponeurosis of the external oblique muscle.

XII. Round ligament of the uterus, in a human female during the fifth month. a. Aponeurosis of the external oblique muscle.
b. Fibres passing from the labium to the aponeurosis of the external oblique.
c. Fibres passing from the labium toward the uterus. d. Internal oblique muscle.
d. e. Fibres given off from the internal oblique to the round ligament.
e. Fibres of the round ligament lost in the peritoneum. f. Fibres passing onto the uterus.

XIII. Dissection of a hæmopod with the testes drawn up in the abdomen. a. External oblique muscle. b. Recti muscles. c. Femoral made by the retraction of the cremaster upwards.

XIV. Dissection of a hæmopod with the testes pulled down. The abdominal wall is removed on the left side. a. External oblique muscle. b. Cremaster of the right side. c. Recti muscles.

a. Viscerae seminales of the left side. e. Left testis. f. Mesothemum attaching the testis to the vesicula seminalis. g. Vas deferens.
b. Band extending from the testis to the vesicula seminalis. f. Vestigial muscle passing from the vesicula seminalis to the testis. i. Peritoneum.
XV. Fig. 1. Dissection of the cremaster muscles of a rabbit. 
- a. External oblique muscle. 
- b. Recti muscle. 
- c. Fibres from the external oblique muscle to the cremaster pouch.
- d. Fibres from the internal oblique muscle. 
- e. Penniform muscular fibres.
Fig. 2. Same dissection with the external oblique muscle raised. 
- a.a. Cut ends of the external oblique muscle.
- b. Internal oblique muscle. 
- c. Cremasteric fibres from the internal oblique. 
- d. Penniform muscular fibres of the cremaster. 
- e. Conus spiral fibres.

XVI. Fig. 1. Dissection of a fetal rabbit one inch long. 
- a.a. Kidneys. 
- b.b. Ureters. 
- d. Urachus with the hypogastric arteries on each side. 
- e. Wolfian bodies.
- ff. Mullerian ducts. 
- gg. Genital glands (testes or ovaries).

1. Elevation of the peritoneum between the genital gland and the point of the mullerian duct where in the male, the epididymis ends & the vas deferens begins. 
2. Continuation of the preceding elevation to the groin.

Fig. 2. Dissection of a fetal rabbit between two & three inches long. 
- a. Testis. 
- b. Vestiges of the Wolfian body. 
- c. Vas deferens. 
- d. Plica gubernaculi. 
- e. External oblique muscle. 
- f. Internal oblique muscle. 
- g.g. Fibres from the internal oblique muscle, passing down with fibres issuing from the abdominal to the Pubis. 
- i. Fibres from the internal oblique muscle ascending to the superficial part of the plica gubernaculi.
XVII. Figs 1 & 2 are copied from Mr. Curling's diagrams, to show his view of the descent of the testis.

Fig. 3 is copied from M. Cloquet, and shows the cremaster formed in loops in front of the gubernaculum.

Fig. 4 is copied from M. Cloquet, and shows a cremaster formed of loops.

Figs 5 & 6 are the cremasters of a newborn child.
Fig. 1.

1. The kidney. 2. The urethra. 3. The peritoneum. 4. Testis. 5. The external urethral sphincter passing down into the belly of the adductor muscle. 6. The bladder. 7. The abdominal ring. 8. Peptic portion of the spermatic. 9. Prostate portion of the spermatic. 10. Portion of spermatic attached to the bottom of the scrotum.

Fig. 2.

1. The testis. 2. The spermatic gubernaculum. 3. The peritoneum. 4. Portion of the spermatic arising from Cooper's ligament. 5. Pubic portion of the muscle.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.