some considered that I had tapped an empyema, but this turned out to be incorrect, and a second incision let out the pus from the pericardium. A patient under the care of Dr. J. F. Woodroffe gave a history and showed physical signs that pointed to an empyema at the upper part of the right lung in the front of the chest; a needle inserted there withdrew pus, and we thought the diagnosis established, but operation revealed that there was nothing the matter with the pleura, but a large pus-containing cavity existed at the upper part of the lung. This was drained, but the patient died two months after. Unfortunately there was no opportunity of exactly determining the cause of this cavity, but probably it was tuberculous. Some years ago I saw a patient in whom his doctor, myself, and a surgeon who was called in, were tempted to drain a tuberculous cavity in the middle posterior part of the lower lobe of the right lung. The cavity appeared to be so localized, and it seemed so likely that the profuse purulent expectoration came almost entirely from it that we hoped to benefit the patient considerably. In this we were completely disappointed. I do not know that the operation shortened his life, but I am sure it rendered it less comfortable. We were the more induced to try and drain this cavity because Mr. Arbuthnot Lane had four years before operated successfully for an ordinary empyema on the same side of the chest. The patient did well, recovered completely, but some two years later began to show signs of phthisis. The physical signs of a large cavity in the lung were quite close to the old operation wound, and we thought it possible that the adhesions in connexion with the cured empyema might in some way have determined the locality of the cavity in the lung. I know one other case in which fatal phthisis developed in the lungs of a woman who seven years before had been operated upon successfully for empyema; but, as far as my experience goes, the proportion of patients who, having been operated upon for empyema, suffer afterwards from pulmonary tuberculosis is not in excess of the proportion of cases of pulmonary tuberculosis among the whole population.

As an example of a rare cause for the expectoration of pus the following case is of interest:

A man aged about 60 was sent to me by Dr. Henry Davy. He had whooping-cough in 1887; since then he had complained of a feeling of something under the upper part of the sternum, and there was a slight pain there. In 1889 he coughed up some pus, after which he felt better; but even since then he still had the feeling under the sternum; he would go for some weeks without any expectoration, then cough up pus. I saw him in 1905, and by then he had had many attacks of coughing up pus. The lungs and larynx were quite normal. There were no tubercle bacilli in the sputum, but there was a curious creak synchronous with respiration to be heard over the sternum. An x-ray picture by Dr. Hugh Walsham showed no evidence of phthisis, but a shadow the size of a florin on the left in the anterior mediastinum. There could be very little doubt that this was an enlarged suppurating gland which periodically discharged into the trachea. Under fresh air treatment the patient got perfectly well.

The last point to which I should like to direct your attention is the association of empyema and general peritonitis. F. T. Lord states that in 38 cases of empyema examined in the *post-mortem* room general peritonitis was present in 7. I have not been through our figures from the *post-mortem* room at Guy's Hospital to see if they reveal the same proportion; but, considering that the pneumococcus is the most frequent cause of empyema and is a cause of peritonitis, it is not surprising that the two conditions are occasionally associated; but it is unlikely that, when they are associated, the patient often recovers, therefore the following case is of interest:

A middle-aged woman came into Guy's Hospital under my care in November, 1907. She gave a history that pointed to her having had pneumonia. There were signs of an empyema at the base of the left lung, and a needle withdrew pus. There was a quantity of free fluid in the abdominal cavity; but the abdominal wall was lax, there was no tenderness, and therefore we thought that she had ascites due to some chronic abdominal disease. Sir Alfred Fripp opened the empyema, which we expected to be a small one, but to our surprise many pints of pus gushed out, and then we noticed that all the fluid in the abdomen had disappeared. The large drainage tube put into the chest passed easily into the abdominal cavity, and could be felt through the abdominal wall. She was much improved by this operation, but her temperature was irregular, and therefore pockets of pus in the abdomen were suspected. Sir Alfred Fripp opened the abdomen and found the omentum glued to the

abdominal wall, but on separating this, general peritonitis was observed, pockets of pus around the liver and kidney were thoroughly mopped out, and the patient rapidly got quite well. She was vaccinated several times with a vaccine of the pneumococci recovered from the pus in the chest. She came to show herself at the hospital eleven months after operation, and we took an x-ray photograph of the chest. The lung appeared quite healthy, there was no thickening of the pleura, there were no shadows in the abdomen, nor was there any deformity in the diaphragm; it appeared of normal height on the left side; the only thing noteworthy was that its excursion was only two-thirds of the normal extent. It is indeed a mystery how with the diaphragm moving constantly so large a hole in it could heal. The patient is not short of breath; she can walk well, and appears in every way to be in robust health.

As far as I know, such a successful case as this is unusual.

REFERENCES.

¹ BRITISH MEDICAL JOURNAL, February 15th and 22nd, 1908. ² *Lancet*, November 3rd, 1906. ³ *Lancet*, March 25th, 1893.

Three Demonstrations

ON

MALFORMATIONS OF THE HIND END OF THE BODY.

GIVEN AT THE ROYAL COLLEGE OF SURGEONS, ENGLAND.

BY

ARTHUR KEITH, M.D., F.R.C.S.ENG.,

CONSERVATOR OF THE MUSEUM AND HUNTERIAN PROFESSOR.

I.—SPECIMENS ILLUSTRATING MALFORMATIONS OF THE RECTUM AND ANUS.

WHEN, in October, 1773, Hunter gave his first course of lectures on the "Principles and Practice of Surgery" at his house in Jermyn Street, introducing, as was his wont, "so much of the Animal Economy as may be necessary to illustrate these Principles," he produced in support of the truth of his teaching those preparations which afterwards formed the nucleus of this museum. On the table now before you there are a number of specimens made by Hunter to illustrate the malformations of the rectum; side by side with them are others from his "Physiological Series" to show the manner in which matter is voided from the hind end in vertebrate animals. Here are other two preparations of malformation of the rectum, made and presented by Sir William Blizard, on which he doubtless gave many a discourse to a long-past generation of students at the London Hospital. The foundation of the museum was thus made on a "teaching" collection. The magnitude of the collection now in the museum, the accumulation of material that requires an expert eye for its proper interpretation, are apt to obscure the fact that in its origin and in its growth the museum is designed not only for the purpose of preserving rare and precious specimens, but also for the purposes of teaching. In order that the unrivalled wealth of material at the disposal of this College may be the better utilized for the advantage and progress of medicine, its Council has committed to Professor Shattock and myself for the present winter session the responsible duty of bringing before you sets of specimens from the museum and explaining to you the facts they show and the principles they illustrate. Teaching is the touchstone of a museum; it discovers both the merits and deficiencies of a collection; we wish to make both known to you, so that you may assist us to improve the first and mend the second.

Altogether there are 37 specimens of malformations of the rectum in the museum, but that my description might be founded on as wide a basis as possible, I have taken the liberty of examining similar preparations in the museums of the metropolitan medical schools, in which there are 77 specimens of malformations of the rectum, the total series thus amounting to 114, which are grouped in the accompanying table. The preparations in museums are selected examples, and yet, when the series now dealt with is compared with the 100 cases collected by Curling,¹ or those tabulated by Harrison Cripps² some fifty years later, it will be found that the museum series is not markedly different from that which

is to be expected in practice. Some of you will go through life without having to deal with a single case, for they are to be found in only 1 of 5,000 births, yet such cases will occur to many of you, and your success in treatment will depend on your knowledge of the condition. My classification differs from that of others in that sex and the relationship of the rectum to the sexual organs are made the basis of grouping. In the male that form of abnormality where the rectum opens into the urethra is made the central form round which the others are grouped; in the female, the type where the rectum opens in the vulva is made the central form (See Figs. 1 and 5).

TABLE I.—Specimens of Malformation of the Rectum in London Museums.

Groups.	In Museum of Royal College of Surgeons.	In Museums of Metropolitan Medical Schools.	Total
A. MALES (see Fig. 2):			
1. Rectum opening in urethra ...	7	26	33
2. Rectum ending as cord at or above base of prostate	0	7	7
3. Rectum ending as cord at site of proctodaeum	2	5	7
4. Rectum ending blindly at proctodaeum	1	6	7
B. FEMALES (see Fig. 4):			
1. Rectum ending in vulva or vagina	1	5	6
2. Rectum ending in cord above upper fornix of vagina	0	5	5
3. Rectum ending as cord at upper fornix of vagina	0	3	3
4. Rectum ending as cord on vagina below upper fornix	0	2	2
5. Rectum ending blindly or as cord at site of proctodaeum	3	7	10
C. MISCELLANEOUS SPECIMENS:			
1. Imperfect	1	5	6
2. Imperforate rectum in females with male form of external genital organs	3	3	6
3. Rectum opening abnormally ...	1	0	1
4. Rare malformations	2	3	5
5. Abnormalities of the rectum in domesticated animals	16	0	16
	37	77	114

MALFORMATIONS OF THE RECTUM IN MALES.

GROUP I.—Males in which the Rectum opens into Urethra.

In Fig. 1 is represented the typical form of this abnormality; the orifice of the rectum is situated at the lower end of the veru montanum, being thus immediately beyond the opening of the uterus masculinus and vasa deferentia. It is valvular in form. In 4 cases the orifice was between 2 and 3 mm. in diameter; in 5 between 1 and 2 mm.; and in 6 merely large enough to take a bristle, therefore too small to allow the passage of faeces. In all specimens that have been laid open the orifice is seen to be provided with a sphincter. Of 22 cases in which it was possible to see the exact position of the orifice, it was found to occur at the lower end of the veru montanum in 17; in 1 it was at the apex of the prostate, in 1 by the side of the veru montanum, in 1 at the internal meatus, and in 1 in the trigone of the bladder. In all of the College museum specimens the orifice is in the typical position. Curling estimated that this form made up rather more than a fourth of cases seen in practice; 60 per cent. of museum specimens belong to this type.

GROUP II.—Males in which the Rectum ends as a Fibrous Cord at or above the Base of the Prostate.

Of this group there is not a single specimen in the College collection; but there are seven examples in other metropolitan museums. From Fig. 2 it will be seen that

Group II represents a greater degree of arrest of development, or of atrophy, of the rectum than is shown in Group I.

GROUP III.—Males in which the Rectum terminates in a Fibrous Cord at the Site of the Proctodaeum (Fig. 2).

Of this group there are two examples in the College collection, and five in the school museums. The nature of this malformation and its relation to the other groups will be apparent when the embryology and evolution of the rectum is dealt with.

Fig. 1.—Section of pelvis of a male child, showing the rectum opening into the prostatic part of the urethra. A, Bladder; B, rectum; C, recto-vesical pouch; D, uterus masculinus; E, intra-cloacal anus; F, prostate; G, proctodaeum; H, external and internal sphincters; I, Cowper's gland.

GROUP IV.—Males where the Rectum ends Blindly at the Proctodaeum (Fig. 2).

There is one specimen of this form in the College collection, and six in the school museums, several of which are of great interest, especially two in the museum of St. Bartholomew's Hospital Medical School (preparations 3647 and 3648), and a third in the museum of Guy's Hospital Medical School (preparation 983). The two preparations first named were obtained from children aged 14 months and 24 months, who had been operated

Fig. 2.—Illustrating the various degrees of imperfection of rectum in the male. The rectum is shaded; the various degrees of imperfection make up a series between the proctodaeum and base of the prostate.

on at birth. A ring marks the site of the congenital septum, and in one of them the mucous membrane of the rectum has spread downwards some distance into the anal canal after perforation.

THE NATURE OF RECTAL MALFORMATIONS.

How is such a series of malformations to be explained? The usual explanation given is that they are the result of an imperfect division of the cloaca. In the series of malformations now described to you there is not one single form that is satisfactorily accounted for thereby. The modern tendency is to explain all abnormalities on a purely

embryological basis; we are only beginning to realize the fact that the earlier processes of development of the mammalian embryo are profoundly modified to serve the purposes of the intrauterine life, and that it is only by appealing to the facts of the "animal economy," as Hunter did, that we may hope to interpret rightly the processes observed by the embryologist. This is especially true of the hind end of the body, parts of which, such as the allantois, have been transformed for the early nourishment of the embryo. The only serious attempt which has been made to explain the abnormalities of the rectum is that of Dr. F. Wood Jones.³ The urethral orifice of the rectum he regards as the original anus; the part of the rectum between that opening and the perineal anus—

Fig. 3.—Diagrams to show the manner in which the cloaca is modified and the termination of the rectum transferred from the cloaca to the perineum in higher vertebrates. (A) the amphibian form: (1) bladder; (2) Wolffian duct (ureter and vas); (3) cloaca; (4) rectum; (5) intracloacal anus; (6) cloacal orifice. M.D., Mullerian duct; (B) form found in the tortoise; (C) form in Monotremes; (D) form found in female marsupial.

which he regards as a new orifice—is a post-allantoic prolongation of the original rectum. To myself, Wood Jones's theory was at first quite satisfying; it explained very well the numerous abnormal forms met with; it was only when tested afterwards by a study of the evolution of the rectum in various vertebrate forms, and with a more complete knowledge of the development of the rectum, that it seemed to me to break down. The key to these abnormalities, I think, is to be found in a study of the comparative anatomy and physiology of the cloaca, rectum, and urogenital passages. Above all, the process of impregnation has to be kept in mind, for it was by the evolution of the penis that the rectum attained an opening on the perineum. In Fig. 3 stages in the evolution of the mammalian form of perineum are exemplified, and on the table are specimens representing those stages. Much of the obscurity regarding the hind end of the body results from an imperfect knowledge of what the cloaca is. The cloaca of the frog is represented in the mammal by the trigone of the bladder together with the urethra; it is a closed passage that at times serves to convey the urine and genital products to their destinations; the faeces have

no lodgement there, only a right of passage. It will be observed from Fig. 4 A that the rectum and ducts of the kidney and genital glands open on the dorsal surface of the cloaca, but the rectum perforates higher up, further from the tail, than the genital and urinary ducts. In the 33 specimens of malformed rectum there was only one which opened in the trigone of the bladder, but that one reproduced exactly the amphibian form. In the tortoise and turtle, in which are foreshadowed so many mammalian structural adaptations, a further step is found (Fig. 4 B); the rectal orifice has moved along the dorsal wall of the cloaca so that it now opens nearer the tail than the genital and urinary ducts; it now opens exactly in the position where the majority of specimens shows the abnormal human rectum to open—in the floor of the urethra just beyond the veru montanum. In the 33 specimens one opened in the trigone of the bladder (the amphibian form), one at the meatus

Fig. 4.—Showing the manner in which the rectum becomes separated from the urogenital sinus (endodermal cloaca) during development of the human embryo. (A) From human embryo, 4 mm. long (about twenty days); after Keibel. (B) From human embryo, 11 mm. long (about thirty-five days); after Keibel. (C) and (D) Later stages of development: 1, Bladder; 2, Wolffian duct (ureter and vas); 3, endodermal cloaca; 4, rectum; 5, anus; c.m., cloacal membrane; U.G., urogenital sinus; A, mesoblast at junction of rectum and endodermal cloaca; B, penis; xx, the limits of the perineal depression (ectodermal cloaca).

of the urethra, one in the sinus prostaticus; the two last named are examples of arrest in the passage from the amphibian to the tortoise form. The group of cases where the rectum ended in a cord on the base of the prostate also represent stages of arrest in passing from the amphibian to the tortoise condition, but in them the arrest was accompanied by an atrophy of the terminal part of the rectum, thus producing a fibrous cord.

To understand the nature of those malformations where the rectum ends blindly at the proctodaeum (see Fig. 2) one must take into consideration the changes in form and function which are seen to occur in the reptilian and lower mammalian cloaca. In the tortoise and turtle the cloaca is becoming modified for sexual purposes; on its ventral wall a phallus or glans has been formed (Fig. 4 B); it is grooved for the conduct of the seminal fluid; the cloaca has become elongated and capable of eversion and intromission. With these sexual modifications the cloaca becomes less capable of serving as a faecal passage, and hence the orifice of the rectum is moved nearer to the

perineum. In the Monotremes the sexual modification is carried a stage further; the rectum now opens into that part of the cloaca derived from the ingrowth of ectoderm—the ectodermal cloaca. The deeper part of the cloaca—the part derived from endoderm—now serves solely as a urogenital passage and is known as the urogenital sinus. The endodermal cloaca becomes the urogenital sinus. In marsupials, and in mammals generally, the cloaca* has become more and more adapted for a purely genital function; in the male it becomes elongated, everted, and its mouth prolonged with the outgrowth of the penis. These modifications will be more fully described in connexion with hypospadias. During the evolution of the higher vertebrates the anus has migrated from an intracloacal to an extracloacal or perineal position. The various forms of malformations of the rectum represent arrested stages of migration (see Fig. 2).

In Fig. 4 are represented stages in the development of the human rectum. It is seen to be gradually separated from the cloaca; the embryologist interprets the appearances to mean that the cloaca is being divided into a dorsal part, which becomes the rectum, and a ventral part, which forms the urogenital sinus. One cannot easily conceive the transformation of a part of the cloaca into a part of the rectum; they are so radically different in structure and function. Nowhere in the animal kingdom is there evidence of such a change. It is clear, I think, that the proper interpretation of Keibel's models is not that the cloaca is being divided, but that the rectum is gradually migrating from the amphibian to the mammalian position, and may undergo arrest at any stage of its progress during the development of the embryo.

CAUSE OF THE ABNORMALITIES.

The key to these abnormalities is likely to be discovered from experiments made on developing animals. Professor Mall⁴ has lately published an account of the examination of 163 malformed human embryos, and in the chorion of every one of them he found evidence of uterine inflammation. Uterine inflammation will be found to be the commonest cause of fetal malformation. One must keep in mind, too, that the migration of the rectum is connected with a sexual process—namely, the evolution of a penis and transformation of the cloaca to form a genital passage. It is, therefore, possible that the cause of arrest may be found in a primary defect of the sexual glands.

MALFORMATION OF THE RECTUM IN FEMALES.

GROUP I.—Females in whom the Rectum Opens in the Navicular Fossa of the Vulval Cleft (see Fig. 5).

This abnormality in the female corresponds exactly to the form in the male where the rectum opens in the

Fig. 5.—Section of pelvis of female infant, showing the rectum opening into the navicular fossa of the vulva. A, Bladder; B, rectum; C, recto-uterine fold; D, symphysis; E, vulval anus; G, cervix; H, proctodaeum (rarely present if rectum opens in vulva); I, urethra; K, clitoris; L, hymen.

floor of the urethra at the lower end of the veru montanum. In both sexes the opening is situated immediately below the opening of the genital ducts into the

cloaca. In the female human embryo the cloaca undergoes a transformation in connexion with the development of the vagina and uterus; Berry Hart⁵ and also Wood Jones³ have described these changes. After the rectum has migrated along the cloaca to its perineal termination, the cloacal ends of the Müllerian ducts become filled with solid rods of cells, and burrow and press downwards, to open nearer the perineum in that part of the cloaca which forms the vulval cleft. In the female the original cloaca is transformed into (1) the trigone of the bladder, (2) the urethra, (3) the space between the labia minora. In the College museum there is only one specimen of the rectum opening in the vulval cleft; there are five in the school museums. Of the 6 cases from which these preparations were derived, 2 died at birth, 1 died at 2½ years of age, another at 5½ years, another at 11 years, the remaining being an adult. Bardeleben⁶ has recently tabulated notes on 31 such cases observed chiefly in adults. A case has been well figured and described lately by Mr. F. S. MacKenzie.⁷ Of all the forms met with the prognosis is by far the most favourable in this class. In one case the opening seemed to be in the vagina, but as no hymen was present it was impossible to identify with certainty the junction of vagina and vulva.

GROUP II.—Females in whom the Rectum ends as a Fibrous Cord in connexion with the Vagina.

There are ten examples of this condition in the London school museums, but not one in the College museum. They represent (see Fig. 6) arrest of development in the

Fig. 6.—Diagram to show the termination of the rectum in 25 female infants (see explanation in text).

migration of the rectum along the cloaca to the perineum. In some recorded cases the rectum is said to have opened into the vagina. In such cases as I have examined the vagina has been divided, the arrested rectum probably preventing the proper fusion of the Müllerian ducts to form the vagina.

GROUP III.—Females in whom the Rectum ends Blindly or as a Fibrous Cord at the Site of the Proctodaeum.

As may be seen from the table on page 1737, there are ten examples of this malformation, three of them being in the College collection. As in the male, this form represents stages of arrest in the passage of the rectum from its cloacal to its perineal position.

It will be observed that the cloaca undergoes less transformation in the female than in the male.

MISCELLANEOUS SPECIMENS.

The two series of abnormalities just described embrace most of the forms of imperfect rectum, but there are also a number of uncommon anomalies which are best grouped together (see Table on p. 1737).

1. *Imperfect Specimens.*—In every museum there are to be found certain preparations which are so imperfect that it is impossible to tell what the condition was in life. These are merely mentioned here to draw attention to the fact that it is necessary to examine and retain the relationships of the rectum to all the parts of the pelvis if a perfect record is to be secured. In the six specimens which are classed here as imperfect, only the conical termination of the rectum being preserved, one has to guess the relationship that obtained during life.

* The term "cloaca" is used throughout in its primitive sense—the common passage for rectum, bladder, and genital ducts. The embryologists have sought to restrict the term to that part of the cloaca derived from endoderm (hind gut).

2. *Females with Clitoris Simulating a Penis and with the Rectum opening into the Urethra* (Fig. 7).—This group of cases is best dealt with under malformations of the external genital organs. There are three specimens in the College collection and three others in the school museums; all six are exactly of the same form; in all the vulva and

Fig. 7.—Female with rectum opening into urethra completed by clitoris (from specimen in College collection).

clitoris are prolonged to form a urethra, the rectum opening in the floor of the urethra immediately below the orifice of the vagina. The abnormal rectal opening in this group is exactly similar to that seen below the veru montanum in the male, and in the vulva of the female.

3. *Abnormal Position of the Anal Orifice*.—In describing the development and evolution of the mammalian rectum, reference was made to: (1) The migration of the rectal orifice from the cloaca to the perineum; (2) to the prolongation forwards of the perineal orifice of the urogenital sinus in the male to form the urethra. Now it occasionally happens that not only is the perineal orifice of the cloaca carried forwards on the out-growing penis, but the rectal orifice is also transplanted forwards with it. Fig. 8 will serve

Fig. 8.—Showing the normal and abnormal sites of anus. A, Normal position; B, perineal orifice; C, scrotal orifice; D, sub-pessile; E, intrapreputial; N.C., neurenteric canal.

to make the matter clear. Esmarch, and later Stieda,⁸ have described cases where the rectum opened in the frenum of the prepuce; it may open on the under surface of the penis, or on the raphe of the scrotum, as is shown by a specimen in the College museum, the only one of this class I have been able to examine; or it may open on the perineum. The perineal raphe, it will be remembered, stretches from the normal anus to the frenum of the prepuce; the termination of the rectum may, in these abnormal cases, be found at any point in the median raphe. These abnormalities can only occur in males; the developmental process which causes the prolongation of the cloaca to form the urethra in these cases extends also to the rectal orifice. The explanation of such will be best given in connexion with hypospadias. Occasion will be taken then to mention those peculiar cases, of which there is no example in the College collection, where the median scrotal raphe is continued back as a free band across the anal orifice to join with the perineal tissue between the anus and the coccyx, as recently

described by Bate⁹ and by Kelly.¹⁰ The specimen in the College collection (No. 765) is unique in that the rectum has two openings: (1) a proctodaeum has grown in and opened into the rectum, thus forming an anus in the usual situation; (2) the cloacal orifice has been prolonged forwards, and opens in the median raphe of the scrotum near the root of the penis. In Fig. 8 the position of another rectal opening or fistula is shown near the point of the coccyx. Curling observed the escape of faecal matter by such an opening—the neurenteric part of the blastopore. There is no example of this condition in the museum.

4. *Rare Malformations*.—Under this heading are classified a number of very uncommon conditions. Preparation No. 16 of the Teratological Series shows an arrest of the cloaca at an early embryonic stage; in No. 649 B the rectum is absent and the proctodaeum has opened into the urethra; in a preparation in the London Hospital Medical College Museum practically the whole of the colon is absent; in the school museum of Guy's Hospital a preparation (No. 983) shows that the proctodaeum has opened into the ventral surface of the rectum in place of into its caudal end; in this case ectopia vesicae with compression of the pelvis were present. Evidently there had been an early disturbance of parts, so that the normal relationship between proctodaeum and rectum had been altered. In No. 558 of the College collection, a specimen presented by Mr. Curling shows a septum across the rectum about 4 in. from the anus. It is the only specimen of its kind known to me, and it is not easily explained. In the Museum of St. Bartholomew's Hospital is a rectum (No. 3648 B) with a cyst attached to its posterior wall; it is exactly in the position and of the form one would expect a derivative of the post-anal gut to occupy.

5. *Abnormalities of the Rectum in Domesticated Animals*.—Of the 16 specimens in the College museum showing abnormalities of the rectum in animals, 8 belong to one type which shows a forking of the rectum with two anal orifices, usually associated with a corresponding dichotomy of all the parts of the hind end of the body, penis, bladder, etc. Posterior dichotomy is represented by 4 specimens derived from birds and 4 from mammals (1 pig, 3 dogs), but we have no human example of this abnormality in the museum. The 8 remaining specimens—of which 6 are derived from the pig, 1 from the sheep, and 1 from the dog—show abnormalities of the rectum and anus similar to those described in man. In 3 sows the rectum opens into the vulval cleft; in another, a female with external genitals of the male type, the rectum opens in the urethra below the vagina. In two male animals the rectum terminates, or has terminated, in the bulbous part of the urethra; there are two specimens in which the proctodaeum is imperfectly formed and the rectum unopened. In one specimen the uterus appears to terminate in the last part of the rectum.

Development of the Proctodaeum.

Many preparations of imperforate rectum show very definitely that the anal canal with the internal sphincter and external sphincters arises in connexion with the perineum and independently of the bowel. One scarcely expected that such could be the origin of the internal sphincter, but there can be no doubt about the matter; the evidence of the specimens is so definite. The rectum proper—the part derived from the hind gut—ends at the entrance to the anal canal just above the valves or folds which Sir Charles Ball has described as joining the upper ends of the columns of Morgagni; the lower ends of the columns are also united by folds or valves; the white line of Hilton occurs just below the columns of Morgagni and marks the junction of the skin with the mucous membrane of the anal canal. Thus the columns of Morgagni, the valves joining the columns above and below, the mucous membrane of the anal canal, the external and internal sphincter are derived from the proctodaeum or perineal ingrowth. Unfortunately, in many cases no care has been taken to preserve the perineum, but the material at my disposal warrants the statement that the condition of development of the anal depression is an uncertain index of the degree to which the rectum is developed. In 7 females in which the rectum opened in the vulva the proctodaeum was absent in all; in 10 in which the rectum

ended at or near the perineum, an anal depression was present in all; in 10 cases where the rectum ended blindly at or above the vagina, the proctodaeum was well developed in 7, partly developed in 1, and absent in 2. Amongst males with the rectum opening into the urethra there were 7 with the proctodaeum well marked, 3 with it partly developed, and an uncertain number in which it was absent. In 7 males in which the rectum terminated blindly at or above the prostate the proctodaeum was present in 4, absent in 3; where the rectum nearly reached the perineum the proctodaeum was well marked in all cases, partly developed in 2, and absent in 1.

In 2 cases, both females, the epithelium of the proctodaeum had budded out irregularly, so as to form diverticula, some of which projected for some distance into the perineal tissue, and undoubtedly correspond to certain diverticula which are found in the anal canal opening under the folds which join together the upper ends of the columns of Morgagni, and which were first pointed out to me by Mr. J. Bernard Dawson.

Associated Malformations.—The following is a list of the lesions associated with imperfect rectum in the human specimens examined for the purposes of this demonstration:

Retained testis	...	...	...	1
Malformed coccyx	...	...	...	2
Imperforate urethra	...	...	...	2
Dilated bladder	...	...	...	5
Low implantation of ureter...	...	...	...	3
Occlusion of ureter...	...	...	...	1
Urachal fistula	...	...	...	1
Hypospadias	...	...	...	1
Ectopia vesicae	...	...	...	1
Talipes	...	...	...	1
Cord to coccyx	...	...	...	1
Right arm deformed	...	...	...	1
Compressed pelvis	...	...	...	2

RESULTS OF OPERATION.

I do not propose to deal with the operative procedures to be adopted for the treatment of malformation of the rectum, but a study of these specimens has forced several matters on my attention. One is the great danger of using a trocar for the relief of the condition; there are eleven preparations mounted purposely to show perforations into the pouch of Douglas or a separation of the coats of the rectum by the use of the trocar; Curling and Harrison Cripps have emphasized the danger of the trocar. There should be no half measures in operating; in 95 per cent. of cases it is physically possible to bring the rectum down to the perineum; if it be not found terminating at the site of the proctodaeum, it will be found perforating the prostate or the lower end of the vagina; if not there, then at the base of the prostate or upper part of the vagina. If unrelieved, death occurs about the fifth day from gangrene and rupture, usually towards the upper part of the colon. The prognosis is bad; an imperforate condition of the rectum appears to react on the economy of the child even before birth, and death commonly ensues, even if the rectum be opened early. The prognosis is favourable in the case of females where the rectum opens in the vulva; in all cases hypertrophy and dilatation of the rectum follows, even if an anus is successfully established. It is important to remember that the external sphincter and also internal sphincter are developed in connexion with the perineum, not with the bowel; hence, if a proctodaeum be present, the surgeon may rely on obtaining an orifice provided with competent sphincters.

[Besides the authorities cited below, the following works may be consulted with advantage: Ballantyne's *Antenatal Pathology*; Dr. William Wright's Report on Recent Teratological Literature, published annually in the *Journal of Anatomy and Physiology*; *The Rectum and Anus*, by Sir Charles Ball.]

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FOOD EXTRACTS MADE FROM YEAST.

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In a recent communication¹ dealing with the relative properties of food extracts made from meat on the one hand, and from yeast on the other, Professor Gamgee discusses the subject in a manner which seems to call for some reply, if only on the principle that it is always well to "hear the other side." In this article I propose to deal entirely with the scientific aspects of the question, and not to touch upon commercial issues.

As one who has been familiar with the chemistry of meat extracts for many years, and who has devoted a considerable amount of practical attention to the chemistry and technology of yeast extract, even before it was manufactured to any extent in this country, I may perhaps venture to claim in this short article the attention of those of your readers who are interested in the subject.

Professor Gamgee's communication can be divided, broadly speaking, into two parts, the one dealing with a comparison of the chemical constituents of extract of meat and extract of yeast, and the other being an attempt to show that the former is beneficial and the latter prejudicial to the human—especially the gouty—organism. Both extract of meat and extract of yeast are, as is well known, highly-complicated mixtures, containing a very large number of nitrogenous and non-nitrogenous substances, of which only some have been isolated or identified. From time to time the presence of new bases and other constituents in both forms of extract is recorded, and it has to be admitted that our knowledge of the chemistry of both these products is exceedingly imperfect. As an instance, I may refer to some papers recently published by Kutscher,² who has obtained from meat extract several hitherto unknown bases to which he gives the names ignotine (?identical with carnosine), novaine, carnitine, oblitine, vitatine, etc., and it is more than probable that others still remain to be discovered in both yeast and meat extracts.

The important bearing of this consideration on the subject under discussion will be obvious a little later. It will not, I think, serve any useful purpose to give a list of all the substances which are known to exist in meat and yeast extracts, the more so as such a list must necessarily be very incomplete, and I propose to deal in the first place with the main compositional resemblances, and then to refer to those differences which exist, or are alleged to exist.

Extract of meat, consisting as it does of a concentrated aqueous infusion of meat, contains those soluble substances which are present in the muscular tissue of the ox, or occasionally of some other animal. These may be roughly classed as nitrogen-containing bodies, non-nitrogenous extractive matters and inorganic salts. Extract of yeast, which is prepared by the suitable treatment of yeast plasma, consists of substances which may be classed in the same three categories. Assuming the same degree of concentration—that is, equal percentages of water in both forms of extract—then the proportions in which these three main groups of constituents exist are practically the same. Taking first the mineral matter: this consists in both cases largely of alkaline chlorides and potassium phosphate. The non-nitrogenous extractive matters consist in both cases of glycogen with other carbohydrates, such as gums, inulin, etc., and lactic acid. Much work remains to be done in connexion with this part of the subject; but as the non-nitrogenous constituents are not usually credited with much physiological activity, it will not be necessary to say more than that the carbohydrate extractives of meat extracts have their counterparts in the extract prepared from yeast.

We now come to the important nitrogen-containing substances to some of which the physiological effects of both classes of extracts are due. It is with these substances that Professor Gamgee almost exclusively concerns himself, holding quite rightly that meat extracts (and the same is equally true of yeast extracts) are not foods in the true sense of the word, but rather food adjuncts or stimulants, and that certain of the nitrogenous bases are the only bodies present in these extracts which are known to be possessed of marked physiological activity.