

**Equine Reproductive Physiology, Breeding
and Stud Management, 3rd Edition**

To Mum and Dad

Equine Reproductive Physiology, Breeding and Stud Management, 3rd Edition

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1

The Reproductive Anatomy of the Mare

1.1. Introduction

This chapter details the anatomy and function of the mare's reproductive system. Further accounts may be found in other texts, such as Ashdown and Done (1987), Frandson and Spurgen (1992), Ginther (1992), Kainer (1993), Dyce *et al.* (1996), Bone (1998), Senger (1999), Bergfelt (2000), Hafez and Hafez (2000) and Le Blare *et al.* (2004). The reproductive tract of the mare may be considered as a Y-shaped tubular organ with a series of constrictions along its length. The perineum, vulva, vagina and cervix can be considered as the outer protective structures, providing protection for the inner, more delicate structures, the uterus, Fallopian tubes and ovaries, which are responsible for fertilization and embryo development. Figure 1.1, taken after slaughter, shows the reproductive structures of the mare, and Figs 1.2 and 1.3 illustrate these diagrammatically. Each of these structures will be dealt with in turn in the following account.

1.2. The Vulva

The vulva (Fig. 1.4) is the external area of the mare's reproductive system, protecting the entrance to the vagina. The outer area is pigmented skin with the normal sebaceous and sweat glands along with the nerve and blood supply normally associated with the skin of the mare. The inner area is lined by mucous membrane and is continuous with the vagina. The upper limit (the dorsal commissure) is situated approximately 7 cm below the anus. Below the entrance to the vagina, in the lower part of the vulva (the ventral commissure), lie the clitoris and the three clitoral sinuses (ventral, medial and lateral; Fig. 1.5). These sinuses are of importance in the mare as they provide an ideal environment for the harbouring of many venereal disease (VD) bacteria, such as *Taylorella equigenitalis* (causal agent for contagious equine metritis (CEM)), *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. Hence,

this area is regularly swabbed in mares prior to covering, and, indeed, in the Thoroughbred industry such swabbing is compulsory (McAllister and Sack, 1990; Ginther, 1992; Horse Race Betting Levy Board, 2008). Within the walls of the vulva lies the vulva constrictor muscle, running along either side of the length of the vulval lips. This muscle acts to maintain the vulval seal and to invert and expose the clitoral area during oestrus, known as winking (Ashdown and Done, 1987; Kainer, 1993).

1.3. The Perineum

The perineum is a rather loosely defined area in the mare, but includes the outer vulva and adjacent skin along with the anus and the surrounding area. In the mare, the conformation of this area is of clinical importance, due to its role in the protection of the genital tract from the entrance of air. Malconformation in this area predisposes the mare to a condition known as pneumovagina or vaginal wind-sucking, in which air is sucked in and out of the vagina through the open vulva. Along with this

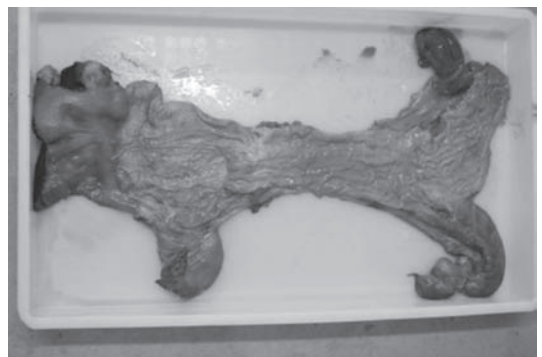


Fig. 1.1. The mare's reproductive tract after slaughter and dissection (see also Fig. 1.3).

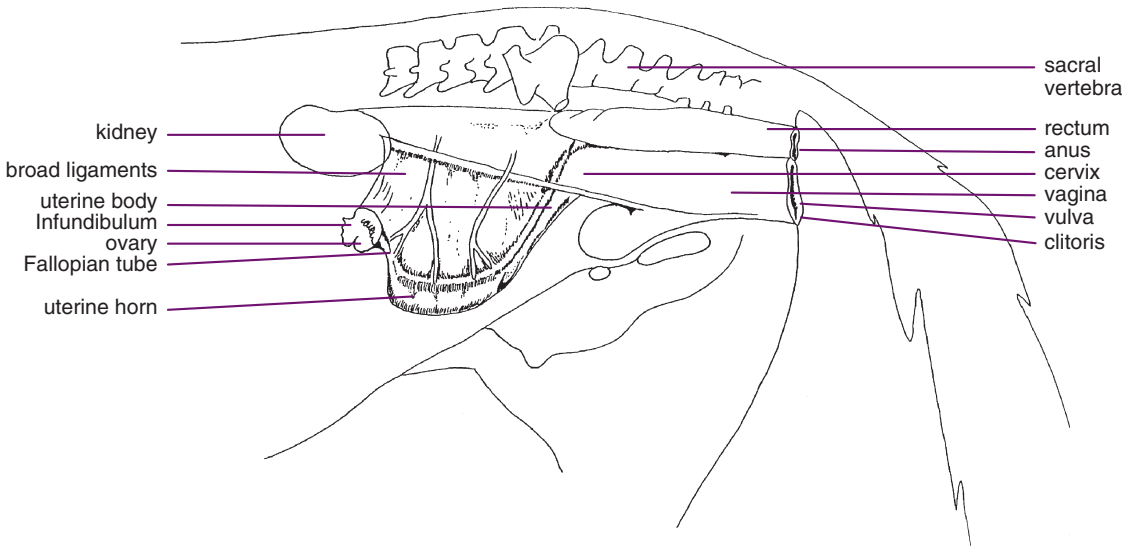


Fig. 1.2. A lateral view (from the side) of the mare's reproductive tract.

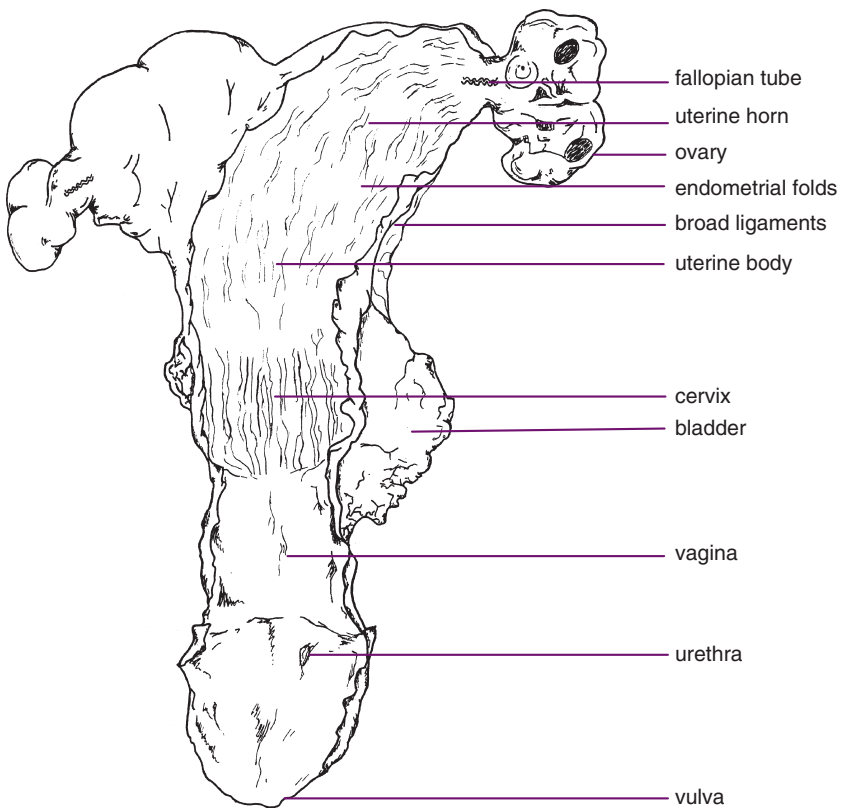


Fig. 1.3. The mare's reproductive tract: a diagrammatic representation of Fig. 1.1.



Fig. 1.4. The vulval area of the mare: in this instance, the conformation of the perineal area is poor with the anus sunken cranially, opening up the vulva to faecal contamination.



Fig. 1.5. The vulva of the mare showing the ventral commissure within which lie the clitoris and clitoral sinuses on either side.

passage of air also go bacteria, which bombard the cervix, exposing it to unacceptably high levels of contamination, which it is often unable to cope with, especially during oestrus when it is less competent. Passage of bacteria into the higher, more susceptible parts of the mare's tract may result in bacterial infections, such as CEM, and other VDs leading to endometritis (uterine infection). Chapter 19 (this volume) gives further details on the causes of VD infection in the mare, all of which adversely affect fertilization rates (Ginther, 1992; Easley, 1993; Kainer, 1993).

1.3.1. Protection of the genital tract

Adequate protection of the genital tract is essential to prevent the adverse effects of pneumovagina.

There are three seals within the tract: the vulval seal, the vestibular or vaginal seal and the cervix; these are illustrated in Fig. 1.6.

The perineal area plus the vulva constrictor muscle in the walls of the vulva form the vulval seal. The vestibular seal is formed by the natural collapsing and apposition of the walls of the posterior vagina, where it sits above the floor of the pelvic girdle plus the hymen, if still present. The tight muscle ring within the cervix forms the cervical seal. This series of seals is affected by the conformation of an individual and also by the stage of the oestrous cycle (Figs 1.7 and 1.9).

The ideal conformation is achieved if 80% of the vulva lies below the pelvic floor. A simple test can be performed to assess this. If a sterile plastic tube is inserted through the vulva into the vagina

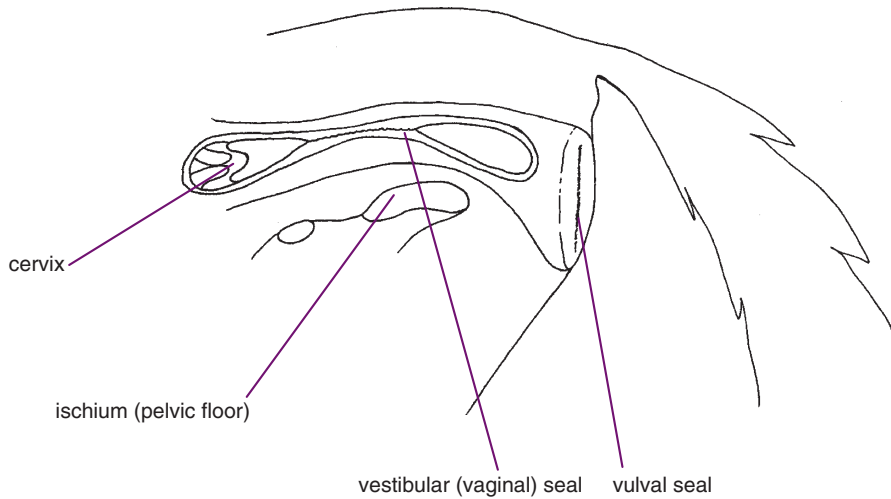


Fig. 1.6. The seals of the mare's reproductive tract during dioestrus.

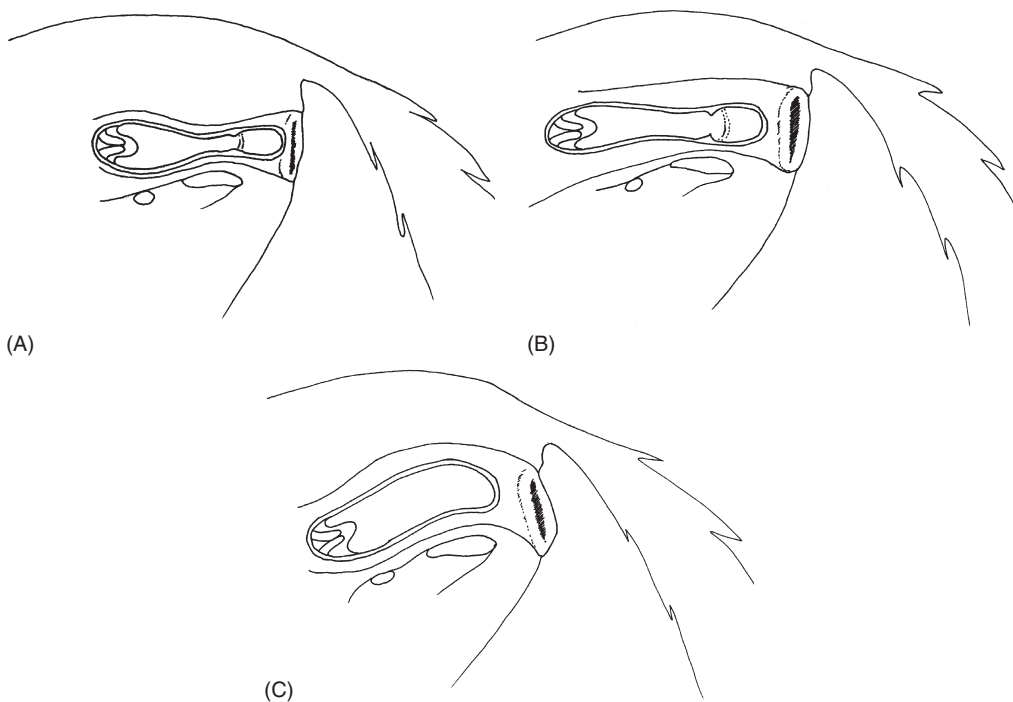


Fig. 1.7. The effect of conformation on the competence of the vulval, vestibular and cervical seals in the mare: (A) a low ischium (pelvic floor) results in an incompetent vestibular seal – in this case, the vulval seal is still competent; therefore, infection risk is limited; (B) a low ischium results in an incompetent vestibular seal – in this case, the vulval seal is also incompetent; therefore, infection risk is increased; and (C) an incompetent vestibular and vulval seal plus a sloping perineal area result in a significant infection risk, especially from faecal contamination.

and allowed to rest horizontally on the vagina floor, the amount of vulva lying below this tube should be approximately 80% in well-conformed mares. This technique is illustrated diagrammatically in Fig. 11.4.

If the ischium of the pelvis is too low, the vulva tends to fall towards the horizontal plane as seen in Fig. 1.7. This opens up the vulva to contamination by faeces, increasing the risk of uterine infection due to pneumovagina. Additionally, a low pelvis causes the vagina to slope inwards, preventing the natural drainage of urine at urination leading to urinovagina, which further increases the risk of uterine infection. Pascoe (1979a) suggested that mares should be allocated a Caslick index derived by multiplying the angle of inclination of the vulva with the distance from the ischium to the dorsal commissure. This index can then be used to classify mares into three types and so predict the likely occurrence of endometritis (Fig. 1.8).

The effect of poor conformation of the perineum area may be alleviated by a Caslick's vulvoplasty operation, developed by Dr Caslick in 1937 (Caslick, 1937). The lips on either side of the upper vulva are cut, and the two sides are then sutured together. The two raw edges heal together, as in the healing of an open wound, and hence seal the upper part of the vulva. The hole left at the ventral commissure is adequate for urination

but prevents the passage of faeces into the vagina (Fig. 1.9).

The chance that a mare requiring a Caslick's operation will pass on the trait to her offspring is reasonably high. This, coupled with the fact that the operation site has to be cut to allow mating and foaling, casts doubt on whether such mares should be bred. Mares that have been repeatedly cut and resutured become increasingly hard to perform a Caslick's operation on, as the lips of the vulva become progressively more fibrous and therefore difficult to suture. In such cases, a procedure termed a Pouret may be carried out (Pouret, 1982). This is a more major operation and involves the realignment of the anus as well as the vulva (Knottenbelt and Pascoe, 2003).

Perineal malformation is particularly prevalent in Thoroughbred mares. It is causal to both pneumovagina (collection of air within the vagina) and urinovagina (collection of urine within the vagina), both conditions being precursors for endometritis and hence infertility. The condition tends to be exacerbated in mares with a low body condition score and also in multiparous, aged mares and those in fit athletic condition. Its continued existence is largely due to the selection of horses for athletic performance rather than reproductive competence (Caslick, 1937; Pascoe, 1979a; Pouret, 1982; Le Blanc, 1991; Easley, 1993).

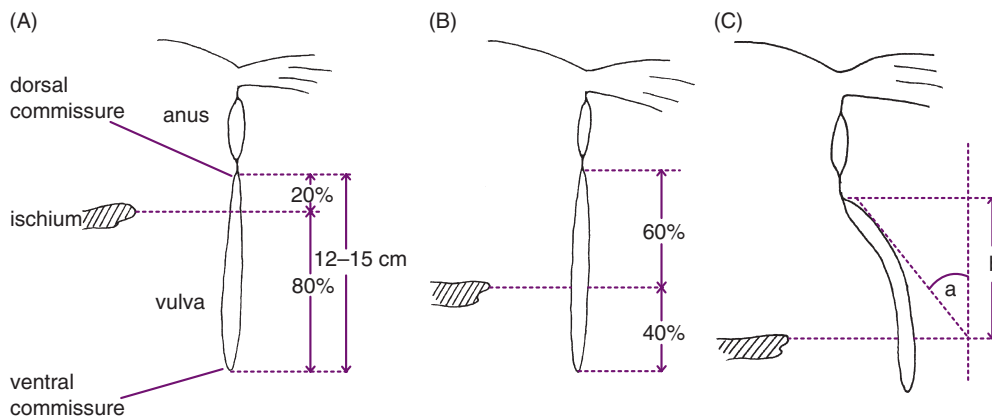
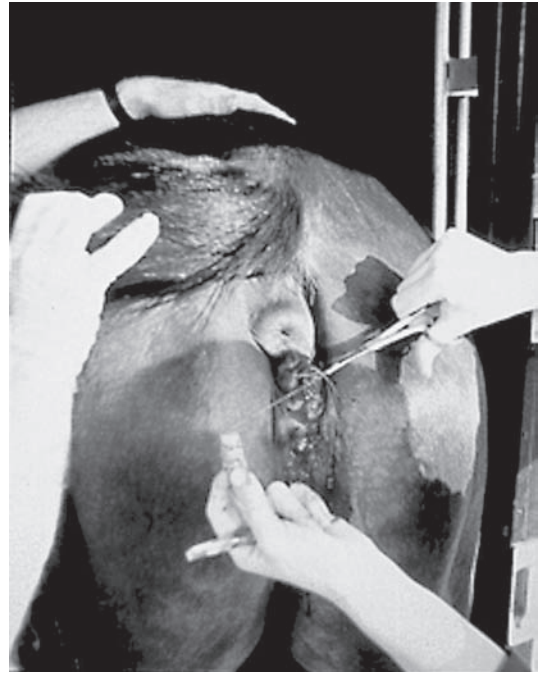


Fig. 1.8. A lateral view of the relationship between the anus, vulva and ischium, indicating: (A) type I mare with good conformation, Caslick index <50 ($b = 2-3$ cm, $a < 10^\circ$) – no Caslick required; (B) type II mare with poor conformation, predisposing to type III in later life, Caslick index $50-100$ ($b = 6-7$ cm, $a = 10-20^\circ$) – no immediate need for a Caslick but likely in later life; and (C) type III mare with very poor conformation, including vulva lips in a horizontal plane, Caslick index >150 ($b = 5-9$ cm, $a \geq 30^\circ$) – Caslick required immediately, significant chance of endometritis and a reduction in reproductive success.

(A)



(B)



(C)



Fig. 1.9. A Caslick operation in the mare showing (A) the cutting of the vulval lips; (B) suturing; and (C) the finished job.

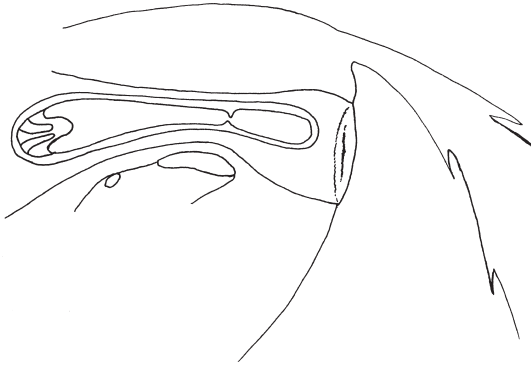


Fig. 1.10. The effect of oestrus on the competence of the vulval, vestibular and cervical seals in the mare: oestrus causes a relaxation of the seals and, therefore, an increase in infection risk.

The oestrous cycle also has an effect on the competence of the three seals. Further details of the effect of the oestrous cycle on the reproductive tract are given in Chapter 3 (this volume). However, in summary, oestrus results in the slackening of all three seals, due to a relaxation of the muscles associated with the reproductive tract, especially the cervix (Fig. 1.10). This allows intromission at covering but also decreases the competence of the reproductive tract seals and so increases the chance of bacterial invasion. In part, this is compensated for by elevated oestradiol levels characteristic of oestrus, which enhance the mare's immunological response, thus reducing the chance of uterine infection, despite the increased chance of bacterial invasion. Recent work by Causey (2007) indicates that the uterus may also be adapted to provide mucociliary clearance of bacteria, a further defence against uterine bacterial invasion (see Section 1.6).

1.4. The Vagina

The vagina of the mare is on average 18–23 cm long and 10–15 cm in diameter. In the well-conformed mare the floor of the vagina should rest upon the ischium of the pelvis, and the walls are normally collapsed and apposed, forming the vestibular seal. The hymen, if present, is also associated with this seal and divides the vagina into anterior (cranial) and posterior (caudal) sections. In some texts the posterior vagina is referred to as the vestibule. The urethra, from the bladder, opens just caudal to the

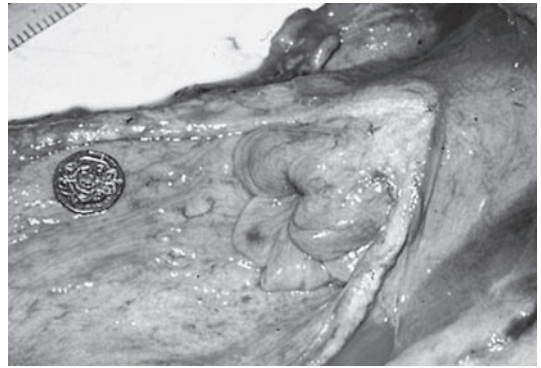


Fig. 1.11. The internal surface of the mare's vagina (coin measures 21 mm in diameter).

hymen. Within the body cavity, the vagina is mainly covered by the peritoneum and is surrounded by loose connective tissue, fat and blood vessels. The walls of the vagina are muscular with a mucous lining; the elasticity conferred by the muscle layer allows the major stretching required at parturition (Figs. 1.11 and 1.16).

The vagina acts as the first protector and cleaner of the system. It is aglandular but contains acidic to neutral secretions, originating from the cervix and small glands situated just cranial to the vulval lips. These acidic secretions are bacteriocidal, but also have the disadvantage of being spermicidal and of attacking the epithelial cell lining of the vagina, necessitating the secretion of mucus by the cells lining the vagina, in order to provide a protective mucous layer. Thus, at ejaculation, sperm is deposited into the top of the cervix and/or bottom of the uterus, to avoid the detrimental effect of the acidic conditions within the vagina. The exact composition of vaginal secretion is controlled by the cyclical hormonal changes of the mare's reproductive cycle (Ginther, 1992; Kainer, 1993).

1.5. The Cervix

The cervix lies at the entrance to the uterus. It is a tight, thick-walled, sphincter muscle, acting as the final protector of the system. In the sexually inactive, dioestrous state, it is tightly contracted, white in colour and measures on average 6–8 cm long and 4–5 cm in diameter; cervical secretion is minimal and thick in consistency. The muscle tone and, therefore,

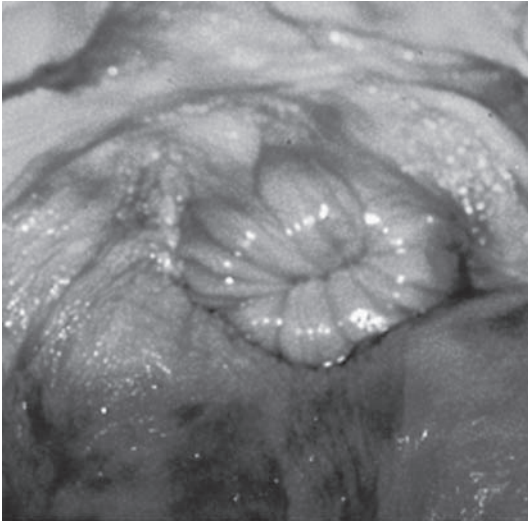


Fig. 1.12. The oestrous cervix protrudes (flowers) into the vagina of the mare.

cervix size, along with its secretion are again governed by cyclic hormonal changes. Muscle tone relaxes during oestrus and there is an increase in secretion, easing the passage of the penis into the entrance of the cervix. The oestrous cervix appears pink in colour and may be seen protruding or ‘flowering’ into the vagina (Fig. 1.12; Lieux, 1970).

The lining of the cervix consists of a series of folds or crypts, as shown in Fig. 1.13. These crypts are continual with the folds in the uterine endometrium and enable the significant expansion of the cervix required at parturition (Ginther, 1992; Kainer, 1993).



Fig. 1.13. The internal surface of the cervix and uterus illustrating the cervical endometrial folds and uterine.

1.6. The Uterus

The uterus of the mare is a hollow muscular organ joining the cervix and the Fallopian tubes (Figs 1.1 and 1.3). This upper part of the tract including the uterus is attached to the lumbar region of the mare by two broad ligaments, outfoldings of the peritoneum, on either side of the vertebral column. The broad ligaments provide the major support for the reproductive tract (Fig. 1.14) and can be divided into three areas: the mesometrium, attached to the uterus; the mesosalpinx, attached to the Fallopian tubes; and the mesovarium, attached to the ovaries (Ginther, 1992).

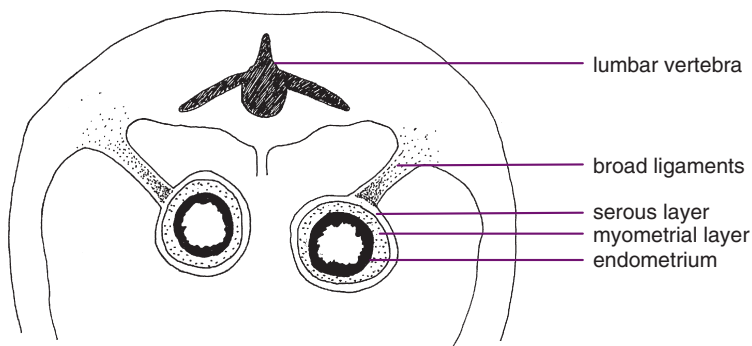


Fig. 1.14. Cross section through the abdomen of the mare illustrating the reproductive tract support provided by the broad ligaments.

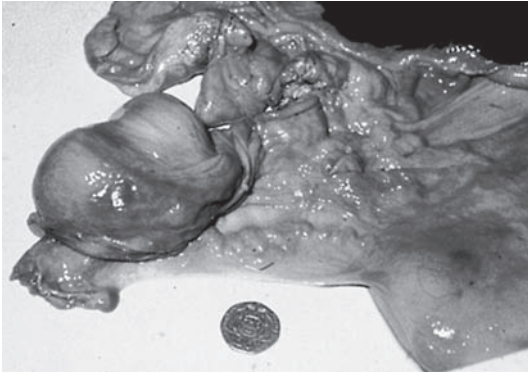


Fig. 1.15. The convoluted Fallopian tube running through the mesovarian section of the broad ligaments, from the uterine horn on the right to the ovary on the left.

The uterus is divided into two areas: the body and the horns. The body of the uterus normally measures 18–20 cm long and 8–12 cm in diameter, and divides into two uterine horns which are approximately 25 cm long and which reduce in diameter from 4–6 cm to 1–2 cm as they approach the Fallopian tubes (Fig. 1.15). The size of the uterus is affected by age and parity, older multipa-

rous mares tending to have larger uteri. The uterus of the mare is termed a simplex bipartitus, due to the relatively large size of the uterine body compared to the uterine horns (60:40 split). This differs from that in other farm livestock, where the uterine horns are the more predominant feature. The lack of a septum dividing the uterine body is also notable (Hafez and Hafez, 2000). *In situ* the uterine walls are flaccid and intermingle with the intestine, the only lumen present being that formed between the endometrial folds.

The uterine wall (Fig. 1.16) consists of three layers: an outer serous layer (perimetrium) continuous with the broad ligaments; a central muscular layer (myometrium); and an inner mucous membrane lining (endometrium). The central myometrial layer consists of external longitudinal muscle fibres, a central vascular layer and internal circular muscle fibres. It is this central myometrial layer that allows the considerable expansion of the uterus during pregnancy and provides the force for parturition. The inner endometrium is arranged in 12–15 longitudinal folds (Figs 1.3 and 1.13) and comprises luminal epithelial cells, stroma of connective tissue or lamina propria and associated endometrial glands and ducts (Fig. 1.16). Collagenous connective tissue cores support these folds. The activity and, therefore, appearance of

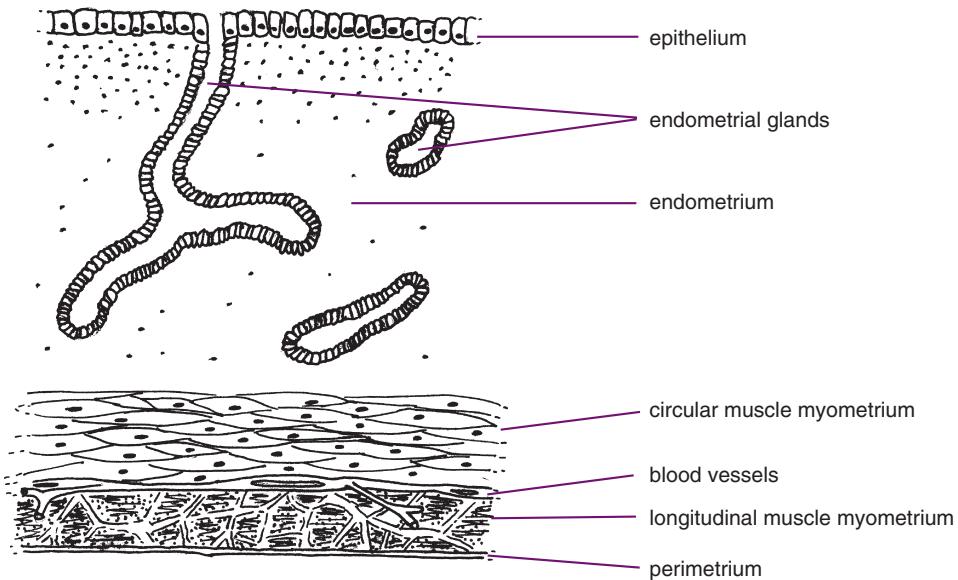


Fig. 1.16. Cross section through the uterine wall.

these endometrial glands are dependent on the cyclical hormonal changes. It is this endometrial layer that is largely responsible for supporting the developing conceptus and for placental attachment and development (Ashdown and Done, 1987; Ginther, 1992, 1995; Kainer, 1993; Sertich, 1998). New work by Causey (2007) suggests that the epithelium of the uterine endometrium exhibits mucus-secreting and ciliated cells, supporting a mucopolysaccharide blanket. These features are also found in the respiratory tract to aid the clearance of foreign material/infection. Hence, Causey (2007) suggests that the presence of such cells in the mare's uterus is indicative of a similar mucociliary clearance mechanism to help eliminate bacteria, and so provides a further defence against uterine bacterial invasion.

1.7. The Utero-tubular Junction

The utero-tubular junction is a constriction or sphincter formed by a high concentration of muscle cells from the circular myometrium of the Fallopian tube. The junction, which appears as a papilla in the endometrium, separates the end of the uterine horns from the beginning of the Fallopian tubes (Fig. 1.17). Fertilization takes place in the Fallopian tubes, and only fertilized ova can pass through this junction and on to the uterus for implantation and further development. Fertilized ova appear to actively control their own passage, possibly via a localized secretion of prostaglandin E (PGE; see Section 5.3; Ball and Brinsko, 1992), leaving the unfertilized ova on the Fallopian tube side of the junction. These then gradually degenerate (Ginther, 1992; Kainer, 1993; Fig. 1.17).

1.8. The Fallopian Tubes

The mare has two Fallopian tubes or oviducts of 25–30cm length, which are continuous with the uterine horns (Fig. 1.15). The diameter of these tubes varies slightly along their length, being 2–5mm at the isthmus end, nearest the uterine horn, and gradually increasing to 5–10mm at the ampulla, nearest the ovary. The division of the Fallopian tube between the isthmus and ampulla is approximately equal. The Fallopian tubes lie within peritoneal folds, which form the mesosalpinx part of the broad ligaments. They have walls very similar in structure to the uterus, but thinner,



Fig. 1.17. The utero-tubular junction in the mare, as seen from the uterine horn side (the dark colour of the uterine endometrium is not natural but serves to allow easier identification of the utero-tubular junction).

composed of three layers: the outer fibrous serous layer, continuous with the mesosalpinx; a central myometrial layer of circular and longitudinal muscles fibres; and an inner mucous membrane. Fertilization takes place in the ampulla, a region lined with fimbriae (hair-like projections), which act to waft unfertilized ova into the ampulla to await the sperm and to waft fertilized ova out of the ampulla and on towards the utero-tubular junction. The ampulla of each Fallopian tube ends in the infundibulum, a funnel-like opening close to the ovary (Sisson, 1975).

The infundibulum in the mare is closely associated with a specific part of the ovary termed the ovulation fossa, which is unique to the mare and is the only site of ova release; in other mammals ovulation may occur over the whole surface of the ovary. The infundibulum is, therefore, relatively hard to distinguish in the mare, not being so evident as a funnel-shaped structure surrounding the whole ovary. The infundibulum is lined, like the ampulla, by fimbriae, which attract and catch the ova guiding them towards the entrance of the Fallopian tubes (Ginther, 1992; Kainer, 1993).

1.9. The Ovaries

The ovaries of the mare are both cytogenic and endocrine in function, producing gametes (ova) and hormones. They are evident as two bean-shaped structures situated ventrally to (below) the fourth and fifth lumbar vertebrae and supported by

the mesovarium part of the broad ligaments. They make the total length of the reproductive tract in the mare in the region of 50–60 cm. In the sexually inactive stage, i.e. during the non-breeding season, the mare's ovaries measure 2–4 cm in length and 2–3 cm in width and are hard to the touch due to the absence of developing follicles. During the sexually active stage when the mare is in season, they increase in size to 6–8 cm in length and 3–4 cm in width; they are also softer to the touch due to the development of fluid-filled follicles (Fig. 1.18). Older, multiparous mares tend to show larger ovaries which can be up to 10 cm in length.

The convex outer surface or border of the ovary is attached to the mesovarian section of the broad ligaments (Figs 1.15 and 1.18) and is the entry point for blood and nerve supply; the concave inner surface is free from attachment and is the location of the ovulation fossa. The whole ovary is contained within a thick protective layer, the tunica albuginea, except for the ovulation fossa. The tissue of the ovary in the mare is arranged as the inner cortex (active gamete-producing tissue) and the outer medulla (supporting tissue). Ova release at ovulation occurs only through the ovulation fossa, and all follicular and corpora lutea (CL) development occurs internally, within the cortex of the ovary (Witherspoon, 1975). The mare differs in these aspects from other mammals, in which the

medulla and cortex are reversed, ovulation occurring over the surface of the ovary and all follicular and CL development occurring on the outer borders. Rectal palpation, as a clinical aid to assess reproductive function in the mare, is not, therefore, as easy to perform as it is in other farm livestock, for example, the cow. However, with the advent of ultrasound, assessment of ovarian characteristics in the mare is now quite accurate (see Sections 11.2.6.3 and 11.2.6.5; Ginther, 1992, 1995; Kainer, 1993; Sertich, 1998; Hafez and Hafez, 2000).

1.9.1. Folliculogenesis (follicular development) and ovulation

The ovary is made of two basic cell types: interstitial cells (stroma), which provide support; and germinal cells, which provide a reservoir from which all future ova are produced. The number of potential ova contained within the female ovary is dictated prior to birth; subsequently, no addition to that pool of ova can be made. These very immature ova are termed oogonia, and there are many more than an individual will use within her reproductive lifetime. These oogonia, with their full complement of chromosomes (64) and surrounding a single layer of epithelial cells, are termed primordial follicles. At birth, the ovary contains many thousands of these primordial follicles which, at varying rates, start to undergo development (folliculogenesis) to form ova mature enough to be fertilized. Folliculogenesis can be divided into two phases (Del Campo *et al.*, 1990; Ginther, 1992; Pierson, 1993; Hafez and Hafez, 2000). The first phase can start to occur anytime after birth and develops these oogonia within their primordial follicles into primary oocytes. These primary oocytes, surrounded by their epithelial or granulosa cells, undergo the first stages of meiosis. This first phase of folliculogenesis is not dependent upon gonadotrophic hormones (reproductive hormones produced by the anterior pituitary; see Section 3.2.2); hence, why some oogonia can start the first phase of folliculogenesis before the onset of puberty. These partially developed primary oocytes, within what are now termed primary follicles, then await puberty, when hormones secreted from the anterior pituitary drive their further development.

From puberty onwards, the second phase of folliculogenesis can occur where primary oocytes develop within their primary follicles and complete the final stages of meiosis in waves, designed to ensure that a regular supply of developed follicles

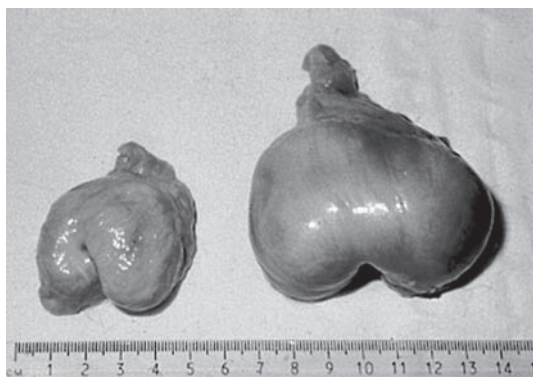


Fig. 1.18. The ovaries of the mare. Note the difference in size between the ovary on the left, which is inactive, and the one on the right, which is active. The concave surface (position of the ovulation fossa) and the convex surface (the hilus, entry point for blood and nerve supply) of the ovary are clearly seen.

is available for ovulation every 21 days during the breeding season. This second phase of folliculogenesis is gonadotrophic hormone-dependent and so is linked to the mare's 21-day cycle. However, not all primary follicles go on to ovulate, many are wasted along the way, degenerating and becoming atretic; in monovular species, such as the mare, normally just one reaches the stage ready for ovulation (Davies Morel and O'Sullivan, 2001).

The length of the second phase of folliculogenesis is unclear in the mare but may be as long as 21 days. Whatever, the waves of second-phase folliculogenesis occur continually and, if they coincide with elevating hormone levels towards the end of the mare's 21-day cycle, will result in a pre-ovulatory or graafian follicle(s) (Ginther *et al.*, 2001, 2003). As the primary follicle is driven by these hormones it develops, its surrounding epithelial cells differentiate into follicular epithelial cells which secrete follicular fluid, filling the cavity surrounding the oocyte. The follicle grows in size as fluid accumulation increases. The primary oocyte itself now also increases in size and develops a thick, outer jelly-like layer, the zona pellucida; it is now termed a secondary oocyte and has a haploid number of chromosomes (32). The secondary oocyte becomes associated with one inner edge of the follicle and lies on a mound of follicular cells

called cumulus oophorus. The epithelial cells surrounding the follicle become organized into two cell populations: the theca membrane, the inner layer of which is vascularized, whereas the outer layer is not; and immediately inside this, the granulosa layer. The follicles continue to develop and are termed graafian follicles (Fig. 1.19).

During this second phase of folliculogenesis the follicle develops hormone receptors, initially follicle-stimulating hormone (FSH) receptors and then luteinizing hormone (LH) receptors. These receptors allow it to develop in synchrony with the oestrous cycle (Chapter 3, this volume). There are three stages in the final development of graafian follicles: recruitment (recruitment of follicles from the pool of available primary follicles); selection or emergence (the selection or emergence of a few as potential pre-ovulatory follicles that undergo further development); and dominance (identification of one, possibly two, follicles that will go on to ovulate and that now start to suppress the development of other follicles). The identification of a dominant follicle is also sometimes termed divergence, as from this stage onwards the dominant follicle (normally 3 cm or greater in diameter) maintains its growth rate while the growth rate of other follicles (termed subordinate follicles) slows and they start to regress (Gastal *et al.*, 2004). The suc-

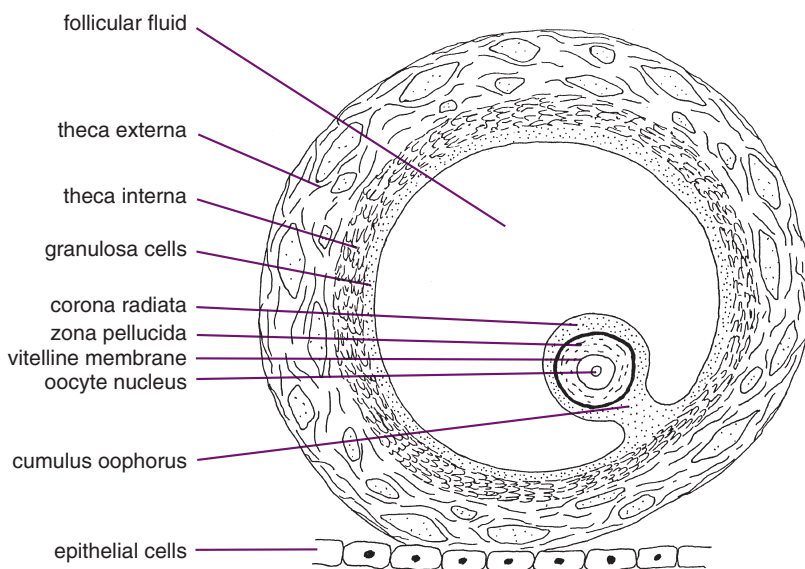


Fig. 1.19. The equine graafian follicle.

cessful development of follicles through these three stages depends on their ability to react to increasing FSH, LH and oestradiol levels, though the exact mechanisms are unclear (Fay and Douglas, 1987; Roy and Greenwald, 1987; Gastal *et al.*, 1999). In the mare when follicles reach 3 cm in diameter this appears to be a critical stage and follicles that develop beyond this size are very likely to become the dominant follicles destined for ovulation and start to inhibit the growth of subordinate follicles (Ginther *et al.*, 2002). The number that develop to a stage appropriate for ovulation depends on a number of factors including breed. In native ponies it is very rare for more than one follicle to develop to a stage appropriate for ovulation. However, in up to 25% of Thoroughbreds two or more dominant follicles may develop and ovulate, resulting in multiple ovulation (Davies Morel and O'Sullivan, 2001; Section 3.2.5).

In those follicles destined to ovulate, follicular diameter increases and at the same time the follicles appear to move within the stroma of the ovary and orientate themselves to await ovulation through the ovulation fossa. Ovulation of the mature follicle occurs in two stages, which normally (99% of occasions) occur concurrently (Ginther, 1992;

Pierson, 1993; Hafez and Hafez, 2000). The two stages are follicular collapse and ova release. The whole process may take from a matter of seconds up to a few hours, with ova release occurring at the later stages of ovulation (J. Newcombe, Wales, 2001, personal communication). The ova and follicular fluid are released through the ovulation fossa to be caught by the infundibulum and passed down the Fallopian tube for potential fertilization. Ovulation of follicles of diameter less than or greater than 3 cm does occur but this is the exception (Sirosis *et al.*, 1989; Ginther and Bergfeldt, 1993).

After the release of the ova and follicular fluid, the old follicle collapses and the theca membrane and remaining follicular epithelial cells become folded into the old follicular cavity. Bleeding from the theca interna occurs into the centre of this cavity, forming a clot. This clot, the theca cells and any remaining follicular epithelial cells make up the corpus luteum (CL or yellow body). Blood capillaries and fibroblasts then invade the CL. It is initially a reddish-purple colour. As the CL ages it becomes browner in colour and, if the mare is not pregnant, regresses and shrinks to yellow then white (corpora albicans) as it becomes non-functional. The luteal

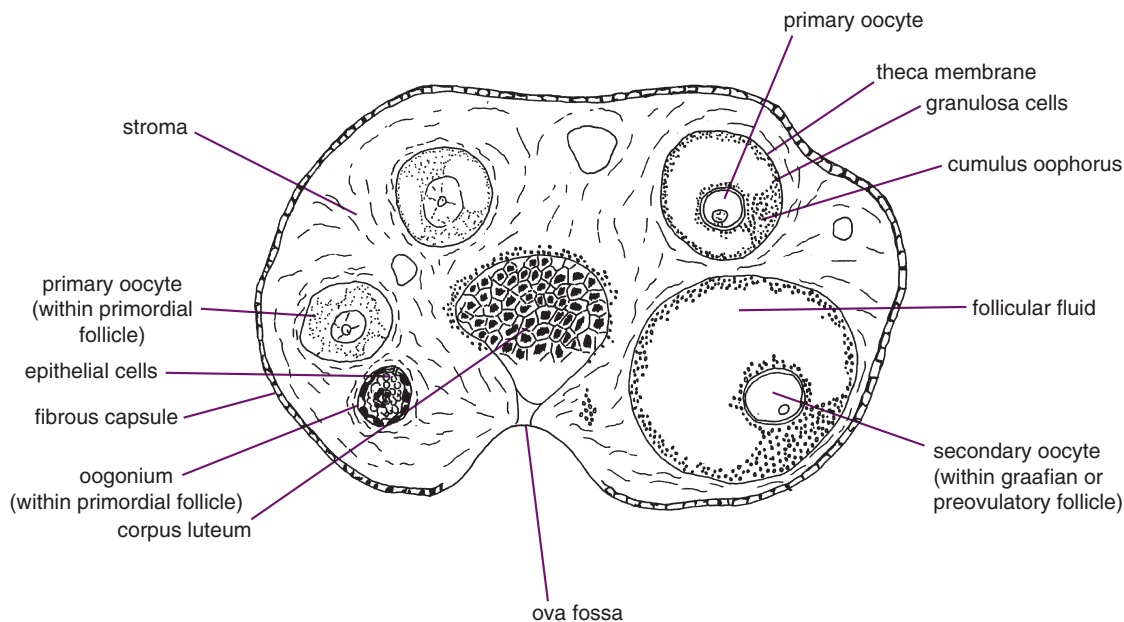


Fig. 1.20. Diagrammatic representation of follicular development and ovulation within the ovary.

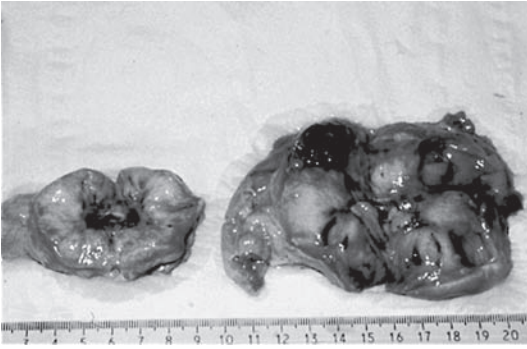


Fig. 1.21. A cross section taken through the two ovaries pictured in Fig. 1.18. Note in the active ovary the CL (dark mass at top left) and the large follicle (hollow or space at the top right).

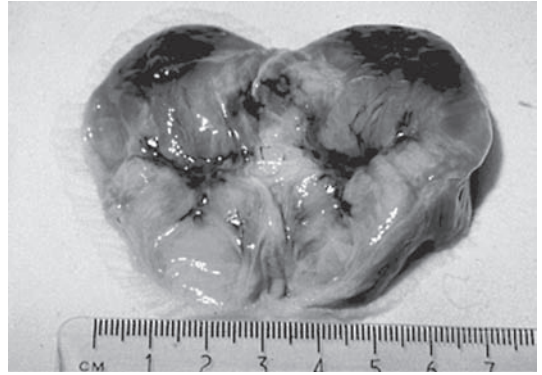


Fig. 1.23. A cross section taken through an active ovary illustrating a large CL at the top of the ovary.

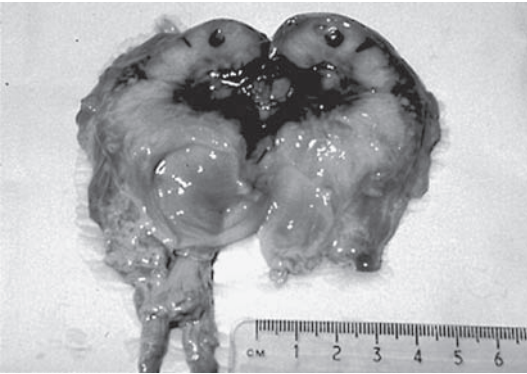


Fig. 1.22. A cross section taken through an active ovary illustrating the presence of a large pre-ovulatory follicle (3 cm in diameter) at the bottom of the ovary.

tissue is then gradually replaced with scar tissue (Fig. 1.20; Vogelsang *et al.*, 1987; Del Campo *et al.*, 1990; Kainer, 1993; Pierson, 1993; Ginther, 1995; Sertich, 1998; Hafez and Hafez, 2000). Figures 1.20–1.23 show sections through a mare’s ovary, illustrating the presence of developing follicles and CL.

1.10. Conclusion

It can be concluded that the reproductive tract of the mare is a remarkable system designed not only to maximize the chance of fertilization and subsequent maintenance of the resulting conceptus in a sterile environment, but also to expel that conceptus successfully at term.