Fertility and Obstetrics in the Horse

Third Edition

Gary C. W. England
BVetMed PhD DVetMed CertVA DVR DipVRep DipECAR DipACT ILTM FRCVS

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Contents

Preface xi
Abbreviations xii

1. Anatomy of the Mare’s Reproductive Tract 1
   1.1 General 1
   1.2 Perineum 1
   1.3 Vulva 1
   1.4 Vestibule 5
   1.5 Clitoris 5
   1.6 Vulvo-vaginal constriction 5
   1.7 Vagina 5
   1.8 Cervix uteri 5
   1.9 Uterus 6
   1.10 Uterine/fallopian tubes (oviducts) 6
   1.11 Broad ligaments 8
   1.12 Ovaries 8

2. Endocrinology of the Oestrous Cycle and Puberty 10
   2.1 General 10
   2.2 Definitions 10
   2.3 Puberty 11
   2.4 Normal cyclicity 12

3. Clinical Examination of the Mare’s Reproductive Tract 20
   3.1 Restraint of the mare 20
   3.2 Approach of the clinician 22
   3.3 External examination 23
   3.4 Manual examination per rectum 23
   3.5 Visual examination per vaginam 24
   3.6 Manual examination per vaginam 25
   3.7 Ultrasound examination per rectum 25
   3.8 Endoscopic examination of the reproductive tract 28
8.4 Equine chorionic gonadotrophin 74
8.5 Placental oestrogens 74
8.6 Ultrasound examination 74
8.7 Time of ultrasound examinations for pregnancy 81
8.8 Protocol for ultrasound examination 82
8.9 Diagnosis of fetal sex 82
8.10 Uterine cysts – structures that may mimic pregnancy 83

9. Normal Parturition 85
9.1 Prediction of parturition 85
9.2 Endocrine control of parturition 85
9.3 Preparation of the environment 88
9.4 Monitoring close to parturition 88
9.5 The ‘overdue’ foal 89
9.6 First-stage parturition 90
9.7 Second-stage parturition (expulsion of the foal) 90
9.8 Third-stage parturition (expulsion of the membranes) 91
9.9 Induction of parturition 91

10. Post-partum Events 95
10.1 Uterine involution 95
10.2 Assessment of uterine involution 95
10.3 Post-partum uterine infection 96
10.4 Assessment of post-partum infection 96
10.5 Post-partum cyclicity 96

11. Normal Expectations of Fertility 99
11.1 Conception and foaling rates 99
11.2 Effect of management on fertility 99
11.3 Methods of investigating reproductive function in mares 100
11.4 Management of the mare at stud 101

12. Non-infectious Infertility in Mares 103
12.1 Prolonged dioestrus 103
12.2 Erratic oestrous behaviour early in the season 104
12.3 Erratic post-partum oestrous behaviour 105
12.4 Silent oestrus 105
12.5 Split oestrus 105
12.6 Luteinised haemorrhagic follicles 105
12.7 Cystic ovaries do not occur in mares 107
12.8 ‘Nymphomania’ 109
12.9 Granulosa cell tumour 109
12.10 Chromosome abnormalities 111
12.11 Abnormalities of the uterine tubes 112
12.12 Uterine cysts 112
12.13 Partial dilation of the uterus 113
12.14 Lesions of the cervix 114
12.15 Persistent hymen 114
12.16 Vaginal bleeding 115

13. Infectious Infertility 116
13.1 General considerations 116
13.2 Non-specific infections/transient endometritis 117
13.3 Mares susceptible to mating-induced endometritis 121
13.4 Chronic endometritis 124
13.5 Venereal pathogen endometritis 125
13.6 Pyometra 126

14. Swabbing and Biopsy Techniques and Diagnosis of Endometritis 128
14.1 Clitoral swabbing (for venereal disease carriers) 128
14.2 Uterine swabbing 130
14.3 Processing the swab 134
14.4 Endometrial biopsy 135

15. Treatment and Prevention of Endometritis 138
15.1 General considerations 138
15.2 Transient endometritis 139
15.3 Mating-induced endometritis 139
15.4 Chronic endometritis 144
15.5 Venereal pathogen endometritis 145
15.6 Pyometra 146
15.7 Urovagina 148
15.8 Cystic endometritis 149
15.9 Post-partum metritis 149

16. Viral Causes of Infertility 151
16.1 Equine herpesvirus 1 and 4 (EHV1 and EHV4) 151
16.2 Equine herpesvirus 3 (EHV3) – coital exanthema 151
16.3 Equine viral arteritis (EVA) 152

17. Problems during Pregnancy 153
17.1 Definitions in pregnancy development 153
17.2 Resorption 154
17.3 Mummification 154
17.4 Abortion 154
17.5 Pseudopregnancy 155
17.6 Pregnancy failure 155
18. **Causes of Pregnancy Failure**
   - 18.1 Bacterial infection
   - 18.2 Equine herpesvirus 1 and 4 (EHV1 and EHV4)
   - 18.3 Equine viral arteritis (EVA)
   - 18.4 Other infectious causes of abortion
   - 18.5 Multiple conceptuses (often twins)
   - 18.6 Mycotic abortion
   - 18.7 Miscellaneous causes of abortion

19. **Other Abnormal Events during Pregnancy**
   - 19.1 Premature placental separation
   - 19.2 Uterine torsion
   - 19.3 Ruptured pre-pubic tendon or abdominal wall rupture
   - 19.4 Hydrops of the fetal membranes
   - 19.5 Pseudopregnancy
   - 19.6 Prolonged gestation

20. **Reducing Infertility Caused by Multiple Conceptuses**
   - 20.1 Prevention of twin conception
   - 20.2 Diagnosis of twins
   - 20.3 Dealing with twin conception

21. **Retained Placenta**
   - 21.1 Normal expulsion
   - 21.2 Examination of the membranes
   - 21.3 Abnormal expulsion

22. **Other Post-partum Problems**
   - 22.1 Vestibular and vulval trauma
   - 22.2 Perineal lacerations
   - 22.3 Recto-vaginal fistula
   - 22.4 Ruptures of the cervix and vagina
   - 22.5 Uterine rupture
   - 22.6 Uterine haematoma
   - 22.7 Internal haemorrhage
   - 22.8 Uterine prolapse
   - 22.9 Invagination of the uterine horn
   - 22.10 Hypocalcaemia
   - 22.11 Post-partum metritis
   - 22.12 Management of the engorged mammary gland

23. **Dystocia**
   - 23.1 Definitions
   - 23.2 Significance of dystocia
23.3 Recognition of dystocia 185
23.4 Non-surgical treatment of dystocia 186
23.5 Surgical treatment of dystocia 188

24. **Manipulation of Reproduction** 190
24.1 Artificial insemination 190
24.2 Embryo transfer 195
24.3 Alternative methods of fertilisation 198
24.4 Alternative insemination techniques 199

25. **The Normal Stallion** 200
25.1 Anatomy 200
25.2 Endocrine control of stallion reproduction 205
25.3 Physiology of sperm production 208
25.4 Mating behaviour 209

26. **Examination of the Stallion for Breeding Soundness** 212
26.1 Bacteriological swabbing 212
26.2 Physical examination 214
26.3 Semen collection 215
26.4 Semen evaluation 217
26.5 Endocrinological testing of the stallion 222
26.6 Ultrasonographic examination of the stallion’s reproductive tract 223
26.7 Endoscopic examination of the stallion’s reproductive tract 224
26.8 Testicular biopsy 225

27. **Diseases of the Reproductive Tract of the Stallion** 226
27.1 Venereal infections 226
27.2 Poor libido 228
27.3 Abnormalities of mating 228
27.4 Poor semen quality 230
27.5 Abnormalities of the ejaculate 232
27.6 Diseases of the scrotum 233
27.7 Diseases of the testes 234
27.8 Diseases of the epididymis 239
27.9 Diseases of the spermatic cord 240
27.10 Diseases of the internal genitalia 240
27.11 Diseases of the sheath 241
27.12 Diseases of the penis 242
27.13 Stallion vices 246
28. Reproductive Surgery of the Stallion 247
   28.1 Castration 247
   28.2 Cryptorchid surgery 251
   28.3 Penile surgery 252

29. Miscellaneous Conditions 254
   29.1 The ‘riggy’ gelding 254
   29.2 Rectal tears 256

30. Breeding Finances 260
   30.1 Breeding terms 260
   30.2 Hidden costs at stud 261

Appendix: Codes of Practice 263
Further Reading 300
Index 301
Preface

In its third edition, this book returns to the original title, ‘Fertility and Obstetrics in the Horse’. The book was initially published 16 years ago by my inspiration and teacher, the late Dr W. Edward Allen. In a sense this remains Ed’s book and I have attempted to maintain his vision of an up-to-date text in which concise but clinically useful information is presented in a readily accessible format.

In this edition the entire text has been revised. Particular attention has been paid to male and female endocrinology and exogenous control of breeding, the aetiology, diagnosis and practical treatment of various types of endometritis, and the evaluation and treatment of stallion diseases. I am grateful to Mr John Newcombe, Dr Jon Pycock and Professor Rob Lofstedt for argument and debate that has influenced my clinical opinion and, indirectly, to the way in which I have presented the new text.

I am indebted to Dr Sarah Freeman for providing some of the new figures, and for caring for our two beautiful daughters and supporting me during the preparation of this edition.

I hope that Ed’s book continues to be a primary source of information for breeders, veterinary students and practitioners, as well as stimulating further study of equine reproduction.

G.C.W. England, 2004
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AI</td>
<td>artificial insemination</td>
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<tr>
<td>AV</td>
<td>artificial vagina</td>
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<tr>
<td>BHS</td>
<td>β-haemolytic <em>Streptococcus</em></td>
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<tr>
<td>CAM</td>
<td>chorioallantoic membrane</td>
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<tr>
<td>CEM</td>
<td>contagious equine metritis</td>
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<tr>
<td>CEMO</td>
<td>contagious equine metritis organism</td>
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<tr>
<td>CH</td>
<td><em>corpus haemorrhagicum</em></td>
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<tr>
<td>CL</td>
<td>corpus luteum</td>
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<tr>
<td>DEFRA</td>
<td>Department for the Environment, Fisheries and Rural Affairs</td>
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<tr>
<td>eCG</td>
<td>equine chorionic gonadotrophin</td>
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<td>EHV</td>
<td>equine herpesvirus</td>
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<tr>
<td>ET</td>
<td>embryo transfer</td>
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<tr>
<td>EVA</td>
<td>equine viral arteritis</td>
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<tr>
<td>FSH</td>
<td>follicle stimulating hormone</td>
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<tr>
<td>GnRH</td>
<td>gonadotrophin releasing hormone</td>
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<tr>
<td>hCG</td>
<td>human chorionic gonadotrophin</td>
</tr>
<tr>
<td>ICSI</td>
<td>intra-cytoplasmic sperm injection</td>
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<tr>
<td>LH</td>
<td>luteinising hormone</td>
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<tr>
<td>PG</td>
<td>prostaglandin</td>
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<tr>
<td>PMN</td>
<td>polymorphonucleocyte</td>
</tr>
<tr>
<td>PMSG</td>
<td>pregnant mare serum gonadotrophin</td>
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<tr>
<td>VI</td>
<td>virus isolation</td>
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Chapter 1
Anatomy of the Mare’s Reproductive Tract

1.1 General

An understanding of the normal anatomy of the mare’s reproductive tract is important to enable distinguishing between normality and reproductive disease. The morphological appearance of the caudal reproductive tract and the normality of the perineum are crucial for maintaining fertility in the mare. Common distortions of the normal anatomy may result in the presence of air within the vagina, increasing the opportunity of bacteria to reach the cranial reproductive tract (13.2).

The normal anatomy provides three ‘seals’ to protect the reproductive tract:

1. The vulval seal – created by apposition of the vulval lips;
2. The vestibulo-vaginal seal – created by the narrowing at the junction between the vestibule and the caudal vagina;
3. The cervix.

1.2 Perineum

The perineal tissue surrounds the vulva and includes tissue ventral to the tail and around the anus. This region is frequently injured at foaling.

- The normal anus is dorsal to, and vertically in line with, the vulva (Fig. 1.1).
- The normal position results in faecal material falling clear of the vulva at defecation.
- The position of the anus is influenced by the body-condition score of the mare. In thin mares, for example, the anus may be sunken-in, i.e. cranial in position compared with normal.

1.3 Vulva

The vulva lies ventral to the anus and is therefore at risk of faecal contamination. The normal vulva is almost vertical in position, and the vulval lips are
apposed (Fig. 1.2). The angle of the vulva should be evaluated with respect to the vertical. Its length should be compared with the position of the bony pelvis (ischial tuberosities) which can be palpated by finger pressure on the perineal tissue adjacent to the vulva.

- The normal vulva is vertical, or no more than $10^\circ$ from the vertical.
- More than 75% of the vulval length is normally positioned ventral to the bony pelvis.
- The vulval lips should be firmly closed.
- Three distinct vulvo-perineal conformational types are recognised.

NB: An increase in the angle of declination and/or a decrease in the length of the vulva below the bony pelvis result in increased likelihood of faecal contamination and of an ineffective vulval seal (Fig.1.2). Presence of air alone will result in a low-grade vestibulitis/vaginitis. With or without bacterial involvement, this may seriously impair fertility.
Figure 1.2  Photographs of the perineal region of two mares: (a) Normal conformation – the vulva is almost vertically orientated and most of the vulva is positioned ventral to the pelvic floor. This conformation results in the establishment of a vulval seal that prevents aspiration of air into the vagina. In addition, there will be little or no faecal contamination. (b) Abnormal conformation – the anus is sunken, causing the vulva to be pulled cranially. The dorsal vulva is almost horizontal in its orientation. This conformation results in an absence of the normal vulval seal, and air may be aspirated into the vagina. There will be significant contamination of the vulva with faeces at defaecation.
Figure 1.2  Continued
1.4 Vestibule

- Extends from vulval lips to vestibule-vaginal constriction.
- Has pink to brownish-red mucous membrane.
- Ventrally houses the clitoris which is surrounded laterally and ventrally by clitoral fossa.
- May be palpated per rectum.

1.5 Clitoris

- The dorsal clitoris is covered by the transverse frenular fold.
- The dorsal surface of the clitoris contains up to three small cavities, the clitoral sinuses (14.1). There is always a central sinus and there may be two lateral sinuses.
- Clitoral sinuses and fossae contain a variable amount of smegma.
- Correct identification of the sinuses is important to enable proper bacteriological screening of mares prior to breeding.

1.6 Vulvo-vaginal constriction

- Just cranial to the external urethral opening.
- May be partial remnants or in maiden mares complete hymen at this junction.
- In genitally healthy mares this constriction forms a secondary line of defence against aspirated air and faecal material.

1.7 Vagina

- A potentially hollow tube which, when undisturbed, is completely collapsed.
- Cyclical changes in the appearance of the vaginal mucosa are minimal.
- Normally there is little bacterial or other contamination of the vagina.
- Clinical examination may result in a transient inflammation.
- Most of the vagina is retroperitoneal.

1.8 Cervix uteri

- A tubular organ 4–10 cm long and 2–5 cm wide that protrudes into the cranial vagina.
- Last line of defence between the uterine lumen and external environment.
- The length, diameter, tone and patency of the cervix varies greatly during different reproductive states (4.2).
• Part of the cervix projects caudally into the potential cavity of the vagina, and its appearance is useful for determining the mare’s reproductive status.
• At no time in the normal mare is the cervix so tightly closed that it cannot be dilated manually.

NB: An abnormal cervix is a common underlying cause in many cases of infertility. Careful examination of the cervix for fibrosis and adhesions is mandatory.

1.9 Uterus

• Roughly T- or Y-shaped in appearance; consisting of a body and two horns (Fig. 1.3).
• Position may be changed by the degree of filling of the bladder or intestine.
• The body runs cranially on the ventral floor of the pelvis and caudal abdomen. The uterus is normally dorsal, dorso-lateral or lateral to the bladder.
• The uterine body averages 20 cm in length.
• The horns bifurcate from the cranial end of the body, and run laterally, or dorso-laterally.
• The horns are an average of 20–25 cm in length.
• The horns are smaller in diameter at their tips.
• The normal non-pregnant uterus has a potential lumen.
• The thickness of the uterine walls, and the tone of the myometrium, vary significantly with reproductive state and age.
• Pregnancy causes gross distortion of the shape of the uterus (7.2).

1.10 Uterine/Fallopian tubes (oviducts)

• The oviducts are tortuous tubes measuring 20–30 cm in length when uncoiled.
• The uterine tube runs within the tubal membrane.
• The oviduct is divided into three regions:
  (1) Isthmus – commencing at the oviductal papilla at the utero-tubal junction;
  (2) Ampulla – the area where fertilisation and early embryonic development occurs;
  (3) Infundibulum – which has distinct fimbriae positioned adjacent to the ovulation fossa, between the proper ligament of the ovary and the tubal membrane.
Figure 1.3 (a) Ventral surface of uterus; (b) dorsal surface of uterus.
Key: h, uterine horn; b, uterine body; o, ovary; l, broad ligament; c, cervix
1.11 Broad ligaments

The two large broad ligaments suspend the uterus in the abdomen.

- Each ligament extends from the dorso-caudal border of a uterine horn and the dorso-lateral border of the body to the sublumbar and lateral pelvic wall.
- The continuous sheets of the broad ligaments are commonly divided into three regions:
  1. Mesometrium – supports the uterus;
  2. Mesosalpinx – supports the oviducts;
  3. Mesovarium – supports the ovaries.
- Smooth muscle fibres within the broad ligament form the proper ligament of the ovary.
- It is not uncommon for there to be remnants of mesonephric ducts and tubules within the mesosalpinx and mesovarium.

1.12 Ovaries

The ovary is bean-shaped and is frequently described as having cranial and caudal poles, a lateral and medial surface and dorsal and ventral margins. The dorsal margin is attached by the mesovarium to the body wall.

- The shape and size of each ovary is variable, dependent mainly on follicular content (4.12, 7.6) (Fig. 1.4).
- Large variations in shape, size and consistency occur in normal mares.
- Anoestrus size ranges from 4 cm × 2 cm × 2 cm to 8 cm × 4 cm × 4 cm; tends to be larger in older and larger mares.
- Suspended in the cranio-lateral part of the broad ligament (the mesovarium).
- The broad ligament between the ovary and tip of uterine horn is the tuba membrane (free margin of mesosalpinx).
- The ovary is covered by an extension of the broad ligament (serosa) except at the ovulation fossa, which is a marked depression on its medial surface.

Cyclical changes within the ovaries

Clinical examination of the ovaries is described in detail in Chapter 3 (see also 4.12); however it is important to remember that the ovaries will contain follicles at many different stages of the cycle. Follicles do not normally protrude above the margin on the ovarian substance unless they are larger than 2.5 cm in diameter. Luteal structures normally protrude above the margin of the ovary for four or five days after ovulation, but not during the later luteal phase.
During anoestrus, ovaries are small and contain small follicles (1–1.5 cm in diameter) and no luteal tissue.

During spring transition, ovaries tend to be very large and contain many variable-sized follicles (up to five or six follicles, each of 3–4 cm in diameter) and no luteal tissue.

During the ovulatory phase, ovaries will variably contain follicles and luteal tissue. It is not uncommon to find significant-sized follicles protruding above the margin of the ovary in mares that are in the luteal phase – at this stage the corpus luteum does not protrude and cannot be palpated.

Figure 1.4  (a) Lateral surface of ovary covered by mesosalpinx containing uterine (Fallopian) tube. (b) Medial surface of ovary showing ovulation fossa. (c) Mature follicle opened to show fluid-filled cavity. (d) Corpus haemorrhagicum sectioned to show extensive haematoma. (e) Formalin-preserved ovary sectioned to show developing corpus luteum with central haematoma. (f) Sectioned ovary containing two mature corpora lutea, one of which has a central haematoma; the corpus luteum of the previous cycle has not yet turned yellow.

Key: u, uterine tube; o, ovulation fossa; f, follicle; ft, fimbriae of uterine tube; h, haematoma; l, luteal tissue; ocl, old corpus luteum
Chapter 2
Endocrinology of the Oestrous Cycle and Puberty

2.1 General

The mare is a seasonally polyoestrous breeder. Ovulation occurs spontaneously at the end of a variable follicular phase. The natural breeding season in the northern hemisphere is May to October. Outside of the breeding season many, but not all, mares become anovulatory.

2.2 Definitions

**Cycle length**

*Cycle length* may be defined as the interval between two successive oestrous ovulations, but multiple ovulations during the same oestrus and dioestrous ovulations also occur. This is a more accurate measurement than the end of one heat to the end of the next.

- Cycle length is usually 21 ± 2 days, but it is very variable.
- Longest cycle length occurs in spring.
- If cycle length is shorter than 18 days suspect endometritis (13.1).
- Persistence of the corpus luteum (CL) is called prolonged dioestrus, i.e. long cycle (4.11). It is normally caused by a dioestrous ovulation.

**Anoestrus**

*Anoestrus* is a prolonged period of ovarian inactivity.

- Usually winter and spring, depending on mare and management system.
- Occasionally in early summer, especially in lactating mares.
- May be small follicles up to 15mm in ovaries.
- No functional CL.
- Diagnosis by palpation of the reproductive tract, ultrasound examination and detection of low plasma progesterone.
Transition from anoestrus to regular cycles (vernal transition)

- Occurs in late winter or early spring, depending on mare and management.
- Variable follicular activity with many follicles, some reaching ovulatory size before becoming atretic.
- Erratic oestrous behaviour.
- Oestrous behaviour may last more than a month before the first ovulation occurs.

Oestrus

Oestrus is the period during which the mare will accept the stallion.

- Usually lasts 4–7 days, but very variable.
- Longest in spring (i.e. first heat of the year).
- Usually ends approximately 24 hours (0–48 hours) after ovulation.
- Under endocrine and psychological control.
- Split oestrus, silent heat and shy breeders may occur.

Interoestrus

The term interoestrus is roughly synonymous with dioestrus, but more accurately describes the interval between two successive heats.

- Usually 14–16 days in length, but may be longer early in the year.
- May be short if CL lysed due to endometritis (13.1) or after prostaglandin (PG) administration (5.3).
- Prolonged due to persistence of the CL (prolonged dioestrus) (4.11).

Luteal phase

The luteal phase is the time period between ovulation and luteolysis, i.e. 14 or 15 days.

- May be shortened by endometritis or PG administration (after five days).
- Short luteal phase may shorten the interoestrous period, but not always, especially in spring.
- Long luteal phase occurs where corpus luteum is not lysed spontaneously, and it may persist for up to three months (prolonged dioestrus).

2.3 Puberty

Little is understood about the events that result in the onset of puberty. It commonly occurs at two years of age, but some mares ovulate as yearlings in late
summer, especially if born early in the year. Factors that influence puberty are thought to include:

- **Photoperiod** – a progressive increased day length is most effective at inducing puberty;
- **Timing** of birth within the year (as above);
- **Good body-condition score**/nutrition anecdotally result in earlier puberty;
- **Pheromones** from other mares in oestrus may enhance the onset of puberty;
- **Training** and/or the administration of anabolic agents may delay the onset of puberty.

NB: Turner’s syndrome (63XO – sex chromosome aneuploidy) may be mistaken for immaturity. Similarly, young mares in deep dioestrus may appear to be pre-pubertal.

**2.4 Normal cyclicity**

During winter, most mares become seasonally anoestrous, especially if wintered out of doors. This is associated with high concentrations of the hormone melatonin secreted by the pineal gland during the night. Melatonin suppresses the release of gonadotrophin releasing hormone (GnRH) by the hypothalamus. Lack of GnRH results in reduced production of luteinising hormone (LH) and follicle stimulating hormone (FSH) by the pituitary gland.

Increasing day length in spring results in:

- Shorter periods of melatonin production;
- Removal of suppression and increased frequency and amplitude of GnRH secretion;
- Increased concentrations or pulsatility of FSH and LH;
- Follicle growth and the onset of behavioural signs of oestrus;
- This period is often described as the transitional phase as it precedes the part of the year with normal oestrus cycles and ovulation.

Ultimately, the spring transitional phase ends with ovulation. There follows a luteal phase and, in the non-pregnant mare, a return to oestrus approximately every three weeks throughout the breeding season. At the end of the breeding season there may be variable oestrus activity until the mare enters winter anoestrus.

Based on these observations it may be seen that the year can be divided into four phases (Fig. 2.1):

1. Winter anoestrus;
2. Spring (vernal) transitional phase;
(3) Ovulatory phase;
(4) Autumn transitional phase.

**Winter anoestrus**

The majority of mares kept out of doors will enter winter anoestrus, with the exception of approximately 30% of native pony mares. Mares are considered to be sexually inactive during winter anoestrus, however an uncommon observation in some is apparent oestrous behaviour, whilst others may have mammary enlargement and production of a milk-like substance.

The lack of gonadotrophin stimulation results in small inactive ovaries that are normally smooth and firm in texture. Often the ovulation fossa is not palpable. The uterus becomes small and atonic, and at biopsy there is glandular atrophy. Other physical characteristics of anoestrus are described in Chapter 3.
Endocrinologically, anoestrus is typified by:

- Baseline concentrations of plasma LH;
- Random fluctuations of plasma FSH (absolute concentrations may be high due to lack of feedback from ovarian oestrogen and inhibin);
- Baseline concentrations of oestrogen;
- Baseline concentrations of progesterone.

Behaviourally, anoestrus is typified by:

- Lack of cyclical changes in behaviour;
- Disinterest or slight resistance to the stallion;
- Disinterest in other mares.

NB: Some mares may show oestrous behaviour or lactation as described above.

**Spring transitional phase**

The transitional phase is a slow period of change from inactivity to the return of normal cyclical activity and may last up to six weeks. The period is often characterised by persistent or irregular oestrous activity. Many owners become frustrated, since they wish to breed the mare and achieve an early foal the next year.

Early in the transitional phase there is moderate follicular development; later there may be exuberant growth of follicles, such that each ovary can be almost twice the size found during the ovulatory phase. Many follicles up to 15 mm in diameter may be present. Later, there may be many follicles greater than 35 mm. In these cases ovaries are large, with palpalable follicles (Fig. 2.2).

![Follicle size vs Days](image)

**Figure 2.2** Follicular growth and regression during the transitional phase. Ultimately one follicle reaches ovulatory size and ability.
Transitional follicles do not ovulate (possibly as a result of a failure of LH synthesis). The lack of oestrogen means there are few oestrogenic effects on the reproductive tract (unlike the situation during true oestrus). Other physical characteristics of the transitional phase are described in Chapter 3.

Endocrinologically, the transitional phase is typified by:

- Increased amplitude and frequency of GnRH release;
- Increased FSH early in the transitional phase, with decreasing concentrations one to two weeks before the first ovulation;
- Slowly-increasing concentrations of LH with a rapid increase before the first oestrus and a peak just after the first ovulation;
- Relatively low concentrations of oestrogen that increase with the follicle wave prior to the first ovulation;
- Low concentrations of progesterone until after the first ovulation.

Behaviourally, the transitional phase is typified by:

- Variable signs between and within mares;
- Some mares have poor signs of oestrus, others have persistent oestrus;
- Many mares show erratic signs of oestrus.

Ultimately, one follicle wave (usually associated with greater oestrogen production and significant oestrogenic effects on the reproductive tract) ovulates and the mare enters the first luteal phase of the year.

**Ovulatory phase**

The transitional phase ends with ovulation, however the events surrounding the transitional oestrus differ from other oestruses of the year, as described below.

Normally, oestrous activity commences after the end of the previous luteal phase when plasma progesterone concentrations decline as a result of endogenous prostaglandin production. Generally, the oestrous cycle can be divided into two phases (Fig. 2.3):

(1) Oestrus – the period of sexual receptivity;
(2) Luteal phase – the period after ovulation during which progesterone is produced by the luteal structures;

NB: The luteal phase may also be considered to have two components: the early luteal phase, during formation of the *corpora haemorrhagica* (termed *metoestrus*); and the late luteal phase from approximately day five after ovulation until regression of the corpus luteum on approximately day 15 (termed *dioestrus*). Frequently, the terminology is confused: ‘dioestrus’ is often used to