Human reproduction

Despite all of the 'trappings' that our societies incorporate into human reproduction, the process comes down to a male gamete (sperm) fertilizing a female gamete (egg or ovum). This cellular union ensures that half of the genetic makeup of the resulting zygote is derived from each parent. Thus, like all forms of sexual reproduction, reproduction in humans serves the bigger purpose of ensuring genetic variation in the species. In both sexes, hormones play a key role in both development of sexual dimorphism (different body forms of males and females) and regulation of sexual physiology. For instance, in males the hormone testosterone:

- determines the development of male genitalia during embryonic development;
- ensures development of secondary sex characteristics during puberty;
- maintains the sex drive of males throughout their lifetime.

The structures of the male and female reproductive system are adapted for the production and release of the gametes (see Figures 6.19 and 6.20). In addition, the female reproductive system ensures a suitable location for fertilization and provides an environment for the growth of the embryo then fetus until birth.

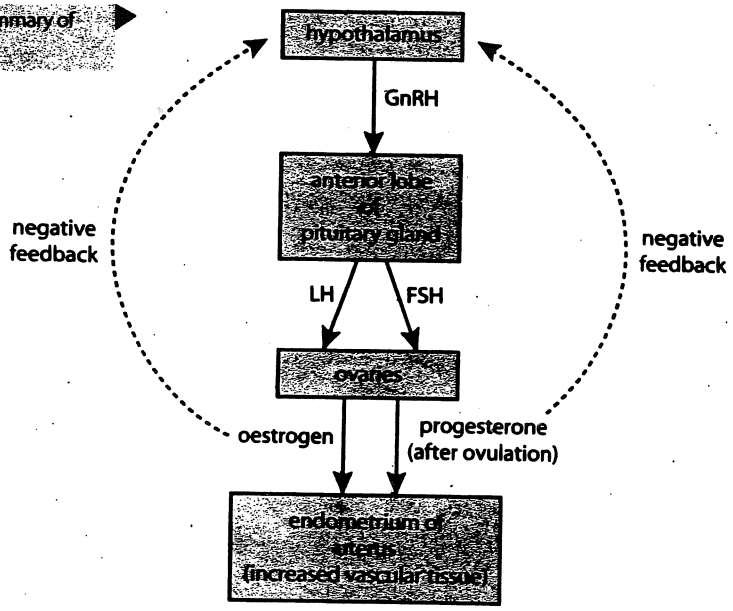
The menstrual cycle prepares the ovaries for ovulation and the uterus for implantation

Starting at the age of puberty, human females begin a hormonal cycle known as the menstrual cycle. Each cycle lasts, on average, 28 days. The purpose of the menstrual cycle is to time the release of an egg or ovum (ovulation) for possible fertilization and later implantation into the inner lining of the uterus. This implantation must occur when the uterine inner lining (the endometrium) is rich with blood vessels (it is described as highly vascular). The highly vascular endometrium is not maintained if there is no implantation. The breakdown of the blood vessels leads to the menstrual bleeding (menstruation) of a typical cycle. This menstruation is a sign that no pregnancy occurred.

Hormones from the brain

A part of a female's brainstem known as the hypothalamus is the regulatory centre of the menstrual cycle. The hypothalamus produces a hormone known as gonadotrophin releasing hormone (GnRH). The target tissue of GnRH is the nearby pituitary gland and it results in the pituitary producing and secreting two hormones into the bloodstream. These two hormones are follicle stimulating hormone (FSH) and luteinizing hormone (LH). The target tissues for these two hormones are the ovaries (see Figure 6.21).

Figure 6.21 Hormonal summary of the menstrual cycle



Effects of FSH and LH on the ovaries

The hormones FSH and LH have several effects on the ovaries. One of these effects is to increase the production and secretion of another reproductive hormone by the follicle cells of the ovary. This hormone is oestrogen. Like all hormones, oestrogen enters the bloodstream. Its target tissue is the endometrium of the uterus. The result is an increase in the blood vessels of the endometrium – or as stated earlier, the endometrium becomes highly vascular.

Another effect of FSH and LH is the production of structures within the ovaries known as Graafian follicles. In the ovaries are cells known

as follicle cells and the true reproductive cells which are at a stage of development called oocytes. Under the chemical stimulation of FSH and LH, the somewhat randomly arranged follicle cells and oocytes take on an arrangement known as a Graafian follicle (see Figure 6.22).

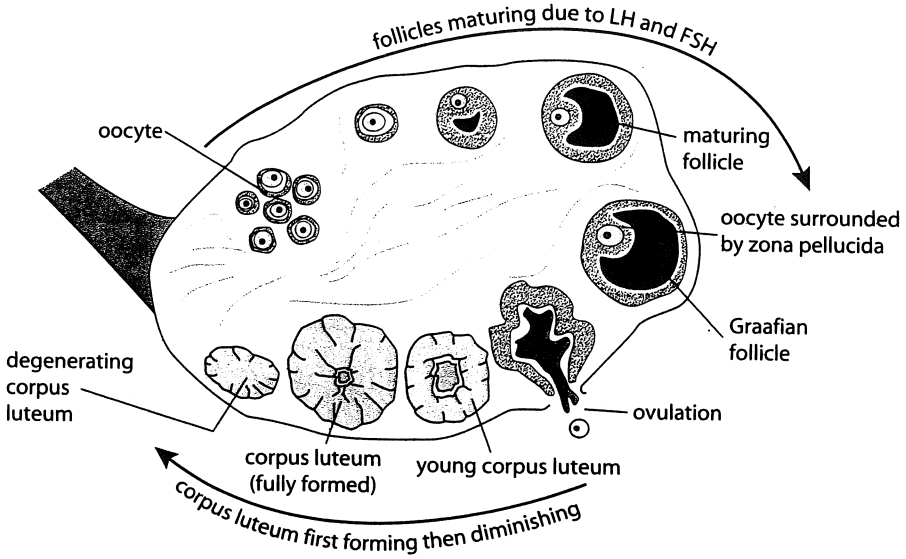


Figure 6.22 Ovary events during a single menstrual cycle (the events shown occur at differing times within a single cycle).

A spike in the level of FSH and LH leads to ovulation (release of the oocyte from the Graafian follicle). The oocyte is accompanied by the inner ring of follicle cells and a glycoprotein membrane coat known as the zona pellucida. This entire structure is known as a follicle and typically enters the Fallopian tube soon after ovulation.

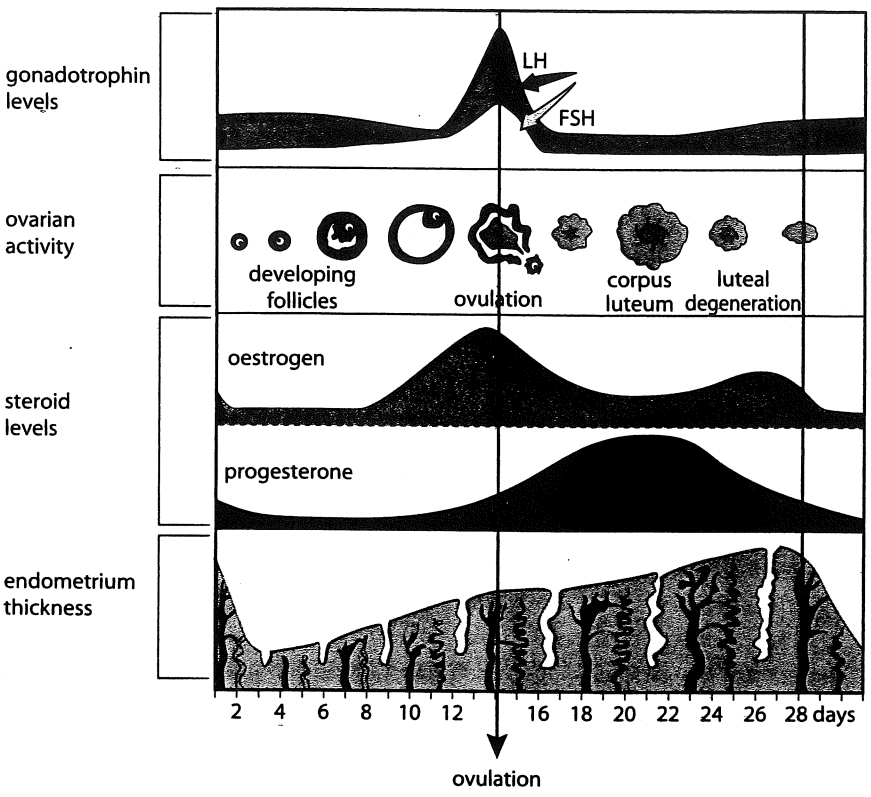
The outer ring of follicle cells remains within the ovary. These follicle cells begin to produce and secrete another hormone, progesterone. The cells of this outer ring begin to divide and fill in the 'wound' area left by ovulation and this forms a glandular structure known as the corpus luteum. The corpus luteum will be hormonally active (producing progesterone) for only 10–12 days after ovulation. Progesterone is a hormone that maintains the thickened, highly vascular endometrium. As long as progesterone continues to be produced, the endometrium will not break down and an embryo will still be able to implant. In addition, the high levels of both oestrogen and progesterone are a negative feedback signal to the hypothalamus. The hypothalamus does not produce GnRH when these oestrogen and progesterone levels are high, so FSH and LH remain at levels not conducive to the production of another Graafian follicle during this time (see Figure 6.21).

Assuming there is no pregnancy, the corpus luteum eventually begins to break down and this leads to a decline in both progesterone and oestrogen levels. As both of these hormone levels fall, the highly vascular endometrium can no longer be maintained. The capillaries and small blood vessels begin to rupture and menstruation begins. The drop in progesterone and oestrogen also signals the hypothalamus to begin secreting GnRH and thus another menstrual cycle begins. Because the menstrual cycle is a cycle there is no true beginning or ending point. We have designated the first day of menstruation as the first day of the menstrual cycle simply because this is an event that can be readily recognized (see Figure 6.23, overleaf).

Birth control pills contain both oestrogen and progesterone. Because the pills keep the levels of these two hormones high in a woman's bloodstream, the hypothalamus does not produce GnRH. Thus, the pituitary does not produce FSH and LH and no new Graafian follicles are produced within the ovaries. The end result is ovulation does not occur.

Many countries have laws intended to regulate reproduction. These laws can range from control of birth control to setting a maximum 'family size'.

Figure 6.23 Events occurring in a 28-day menstrual cycle.



Pituitary hormones: FSH and LH

bind to FSH and LH receptors in the membranes of follicle cells.

FSH stimulates these changes:

- development of oocyte in the follicle
- thickening of follicle wall
- secretion of follicular fluid
- secretion of estrogen by follicle wall.

LH stimulates these changes:

- completion of meiosis in the oocyte
- partial digestion of the follicle wall allowing it to burst open (ovulation)
- growth of the corpus luteum which secretes estrogen and progesterone.

Ovarian hormones: estrogen and progesterone

are absorbed by female cells, where they influence gene expression and therefore development.

Estrogen causes these changes:

- thickening of endometrium
- blood vessel growth in endometrium
- increase in FSH receptors in follicle
- inhibition of FSH secretion and stimulation of LH secretion when estrogen levels are high.

Progesterone causes these changes:

- maintenance of thickening of the endometrium with many blood vessels
- inhibition of FSH and LH secretion.