

Lecture 19

Chapter 18 NEUROENDOCRINE CONTROL OF MENSTRUAL PHASE

Dramatic changes in structure/secretory capacity of endometrium of uterus occur during ovarian cycle in female-induced by both E and P

- 1) **follicular phase:** ↑ E from growing follicle
- 2) ↑ E stimulates proliferation of endometrium of uterus
- 3) ↑ E increases P receptors in uterus
- 4) just before ovulation, follicle stops secreting E: ↓ E titers in blood
- 5) **luteal phase:** E & P from corpus luteum stimulated continued growth/proliferation of coiled blood vessels of endometrium
- 6) tubular glands of endometrium fill with glycogen
- 7) enzymes accumulate in connective tissues of endometrium

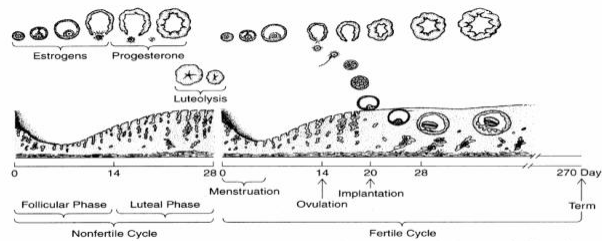


Figure 18.12 Cycle of uterine endometrial growth and development during nonfertile and fertile cycles in the human female.

- 8) endometrium swells/thickens 4-6 mm: growth glands, blood vessels & connective tissues
 - a) endometrial cells: continual source of nutrients for fertilized ovum
 - b) ovum not fertilized; corpus luteum degenerates on Day 8 post ovulation & stops secreting E & P
- 9) decrease in E & P
 - a) causes hemorrhagic changes in endometrium onset of menstruation
 - b) necrosis of endometrium
 - c) arterioles of endometrium constrict → slowing of circulation
 - d) blood enters vascular layer of endometrium → blood pooling
- 10) gradually outer layers of endometrium separate from uterus at site of hemorrhage
- 11) prostaglandins produced by uterus stimulates uterine smooth muscle to contract rhythmically
 - a) discharge of blood (20-200 ml)/endometrial cells = menstrual flow (5-7 days)
 - b) ↑ prostaglandin = uterine contractions = menstrual cramps (dysmenorrhea)
 - c) prostaglandin act on smooth muscle in other areas of body → nausea, vomiting & headache

Estrous Cycle

Periodic episodes of "heat" (estrus) marked by sexual receptivity in mature females of most mammalian species

Duration of *follicular & luteal phases of reproductive cycle vary among different mammals*

- 1) primates: equal duration follicular & luteal phases
- 2) nonprimate mammals: luteal phase much shorter

Humans:	28 d → 13 x/yr
Nonprimates:	spring → 1/yr
lab rat:	4 d → polyestrous

Four major differences between cycles of menstrual & estrous mammals

Estrous mammals

- 1) luteal phase greatly reduced
 - little/no proliferation & shedding of endometrium → no menses*
 - estrous vagina show pronounced changes in epithelial morphology to monitor cycle
- 2) estrous cycle sensitive to environmental (seasonal) factors
- 3) period in which follicle ready for ovulation, female becomes receptive to male
 - a) exhibition of pronounced behavioral changes increasing probability of mating
this period termed *estrus (female is "in heat")*
- 4) some estrous spp. (cat, rabbit) ovulation normally triggered during estrus by coitus; coitus seldom occurs at times other than estrus
ovulating response to coitus assures high % of fertilizations in response to mating

majority of estrous mammals ovulation occurs independent of coitus
(e.g. menstrual mammals)

*shedding uterine lining

TABLE 18.2 The Estrous Cycle of Various Mammalian Species*

Species	Length of cycle (days)	Duration of estrus	Ovulation	
			Type	Time
Cow (<i>Bos taurus</i>)	21	13–14 hours	Spontaneous	12–16 hours after end of estrus
Goat (<i>Capra hircus</i>)	20–21	1–3 days	Spontaneous	30–36 hours after onset of estrus
Sheep (<i>Ovis Aries</i>)	16	20–48 hours	Spontaneous	12–24 hours before end of estrus
Pig (<i>Sus scrofa</i>)	21	2–3 days	Spontaneous	35 hours after onset of estrus
Horse (<i>Equus caballus</i>)	19–23	4–7 days	Spontaneous	1–2 days before end of estrus
Dog (<i>Canis familiaris</i>)	60	7–9 days	Spontaneous	1–3 days after start of estrus
Cat (<i>Felis catus</i>)	–	4 days with male; 9–10 days without male	Induced	20–30 hours after mating
Ferret (<i>Mustela furo</i>)	–	Continuous	Induced	30 hours after mating
Mink (<i>Mustela vison</i>)	8–9	2 days	Induced	40–60 hours after mating
Fox (<i>Vulpes vulpes</i>)	90	1–5 days	Spontaneous	1–2 days after onset of estrus
Ground squirrel (<i>Citellus tridecemlineatus</i>)	16	6–11 hours	Induced	8–12 hours after mating
Guinea pig (<i>Cavia porcellus</i>)	16	20 hours	Spontaneous	10 hours after start of estrus
Golden hamster (<i>Mesocricetus auratus</i>)	4	10 hours	Spontaneous	8–12 hours after start of estrus
Mouse (<i>Mus musculus</i>)	4	10 hours	Spontaneous	2–3 hours after start of estrus
Rat (<i>Rattus norvegicus</i>)	4–5	13–15 hours	Spontaneous	8–10 hours after start of estrus
Rabbit (<i>Oryctolagus cuniculus</i>)	No cycle	Continuous	Induced	10 hours after mating
Rhesus monkey (<i>Macaca mulatta</i>)	28 ^b	None	Spontaneous	14 days prior to onset of menstrual bleeding
Human (<i>Homo sapiens</i>)	28 ^b	None	Spontaneous	14 days prior to onset of menstrual bleeding

* From van Tienhoven [35], with permission.

^b Menstrual cycle.

HORMONAL CHANGES DURING PREGNANCY

PREGNANCY

begins when fertilized ovum implanted in uterine endometrium

1) ↑E & P inhibit GnRH secretion by hypothalamus → ↓ LH & FSH

- a) no follicular development
- b) no ovulation
- c) no menstruation

2) prolactin

- a) maternal pituitary
- b) titers increase progressively & reach maximum at birth
- c) essential for E & P stimulation →
 1. maternal breast development
 2. milk synthesis

3) relaxin

- a) hCG stimulates CL → relaxin 0-8 weeks
- b) after this time endometrium secretes
- c) relaxes pelvic ligaments in preparation of parturition (birth)
- d) with P inhibits uterine contraction → premature expulsion of fetus

4) insulin

- a) 3rd month from maternal pancreas
- b) maternal response → decreased sensitivity to insulin
- c) severe insensitivity → gestational diabetes
- temporary condition returns normal after birth

5) aldosterone

- a) maternal adrenal cortex
- b) maintain adequate Na⁺ levels in maternal circulation
 1. Na⁺ uptake by fetus
 2. Na⁺/water retention → ↑ maternal/fetal plasma volumes

6) cortisol

- a) maternal adrenal glands
- b) ↑ free/protein bound cortisol during pregnancy
- c) E → maternal liver → cortisol binding globulin (CBG)
- d) ↑ maternal adipose tissue volume & development of mammary glands
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- b) free/protein bound cortisol during pregnancy
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7) thyroxine (T₄) and triiodothyronine (T₃)

- a) maternal thyroid ↑size
- b) ↑ T₄/T₃ production
- c) ↑ basal metabolic rate
- d) ↑ resting pulse rate
- e) hormones ↑ maternal cardiopulmonary function
 - ↑rate of delivery of O₂/nutrients to developing fetus