Section 14.3: Review Answers

Student Textbook page 502

1. Chromosomal sex, also known as genetic sex, is determined genetically through the chromosome combination XX or XY. Reproductive sex refers to the physical expression of male or

female anatomical structures based on the presence or absence of specific hormones that are secreted after the seventh week of prenatal development.

2. Students should reproduce the negative feedback loop shown in Figure 14.13 on page 494 and label it.

3. (a) *male puberty*: the production of GnRH increases in the hypothalamus; GnRH acts on the anterior pituitary gland, causing it to release LH and FSH. These hormones stimulate the testes to begin producing sperm and releasing testosterone. Testosterone fuels the complete development of the sex organs and the secondary sexual characteristics.

(b) *female puberty*: the production of GnRH increases in the hypothalamus; GnRH acts on the anterior pituitary gland, causing it to release LH and FSH. These hormones stimulate the ovaries to produce estrogen and progesterone, which fuel the development of the secondary sexual characteristics and the onset of the monthly reproductive cycle.

(c) *the ovarian cycle*: This cycle begins when the pituitary gland increases the level of FSH, which stimulates one follicle to mature. The maturing follicle releases estrogen and some progesterone. The rising level of estrogen inhibits the release of FSH and triggers release of GnRH, which leads to an increase in LH—the hormone that stimulates the burst of the follicle, the release of the ovum, and the development of the corpus luteum. The corpus luteum secretes progesterone and some estrogen, which inhibit FSH and LH production; the corpus luteum then degenerates, decreasing the levels of progesterone and estrogen, which causes FSH to increase and begin the ovarian cycle again. (Fertilization can interrupt this process.)

(d) *the uterine cycle*: begins when the levels of progesterone and estrogen are low (the corpus luteum has degenerated). Levels of estrogen gradually increase as a new follicle matures and the endometrium begins to thicken. Once the ovum has been released and the corpus luteum is producing even more progesterone and estrogen, the endometrium thickens rapidly. Once the corpus luteum degenerates, the endometrium is shed and the cycle begins again. (Fertilization can interrupt this process.)

4. (a) A – follicle stimulating hormone (FSH)

B – estrogen

C – luteinizing hormone (LH)

D – progesterone

(b) Region E on this graph represents the follicular phase of the cycle. The follicular phase spans the length of time between the first day of menstruation and the moment of ovulation. Prompted by the hypothalamus, the pituitary gland releases follicle-stimulating hormone (FSH). This hormone stimulates the ovary to produce around five to 20 follicles, which bead on the surface. Each follicle houses an immature egg. Typically, only one follicle will mature into an egg, while the others die away.

(c) Region F represents ovulation. Ovulation means the release of a mature egg from the ovary surface. This occurs roughly at mid-cycle, around two weeks or so before the onset of menstruation. During the follicular phase, the ripening follicle causes a rise in the level of the sex hormone estrogen. The hypothalamus in the brain recognizes these rising levels and releases a chemical called gonadotropin-releasing hormone (GnRH). This hormone prompts the nearby pituitary gland to produce boosted levels of luteinizing hormone (LH) and FSH. Within two days, ovulation is triggered by the high levels of luteinizing hormone.

(d) Region G represents the luteal phase of the cycle. During ovulation, the egg bursts from its follicle. However, the ruptured follicle remains on the surface of the ovary. For the next two weeks or so, the follicle transforms into a structure known as the corpus luteum. This structure starts releasing the sex hormone progesterone, along with small amounts of estrogen. This hormonal combination maintains the thickened uterine lining, awaiting implantation of the fertilized egg.

(e) Area H caption: Blood levels of pituitary *and* ovarian hormones.

Area I caption: Endometrial Changes

(f) A possible caption for this entire diagram could be:

The menstrual cycle is complex. It is controlled by a variety of glands and their associated hormones. The hypothalamus influences the nearby pituitary gland to secrete FSH and LH, which prompt the ovaries to secrete their sex hormones, principally estrogen and progesterone. The menstrual cycle is a negative feedback system, which means all of the structures and glands are influenced by the activity of the others.

5. Both testosterone and estrogen are responsible for stimulating the development of the secondary sexual characteristics. While testosterone levels may decrease over time, they never cease and the functions they fuel never cease. Estrogen production in the ovaries ceases in females sometime during mid-life.

6. The human menstrual cycle combines events in the female's ovary and the uterus to create the most favourable conditions for a zygote to implant successfully and be nourished into a fetus.

7. In an adolescent male whose anterior pituitary produces FSH we would expect spermatogenesis to occur. It would occur at a reduced level, because spermatogenesis is also influenced by testosterone. And as this male does not produce LH, his testosterone levels will be lower than normal, and thus so will his spermatogenesis. Also with a low LH level, and thus a low testosterone level, we would see a reduction in the secondary sex characteristics, such

as the enlargement of the penis and testicles; there would be a reduction in muscle mass development; as well as a reduction in hair production on areas such as the face and chest. Students' flow charts or diagrams should show an interruption in the negative feedback loop.

8. A large injection of testosterone would result in high levels of testosterone in the blood. The hypothalamus would respond by reducing the amount of GnRH, which would result in a reduction in the amount of LH released into the blood. At the same time, the anterior pituitary would also recognize high levels of testosterone in the blood. In response, less LH would be released from the anterior pituitary into the bloodstream. Low levels of LH result in the interstitial cells of the testis producing less testosterone.

This negative feedback loop keeps testosterone levels relatively constant in the body.