Name _____ Date _____

The Human Menstrual Cycle

Lab 31

Background

When a human female is born, her ovaries already contain the primary oocytes that will mature and produce eggs during her lifetime. Maturation of primary oocytes generally begins between the ages of 12 and 14, when the female reaches sexual maturity. Most commonly, eggs usually mature every 28 days or so, usually one at a time, in alternating ovaries. The rhythmic maturation of eggs and the events that accompany the process are termed the *menstrual cycle*.

Each egg matures inside an egg sac, or *follicle,* near the surface of one of the ovaries. When the egg is fully mature, the follicle bursts. The egg is released in a process called *ovulation.* Cilia sweep the egg into the Fallopian tube, which leads to the uterus. An unfertilized egg will pass from the female's body within a short time. The lining of the uterus, which had been prepared for the arrival of an embryo, deteriorates and also passes out of the body. This periodic loss of tissues and fluids from the uterus is a normal function known as *menstruation.* A menstrual cycle is considered to begin at the onset of menstruation.

Hormones carried in the bloodstream bring about the changes in the menstrual cycle by means of "feedback mechanisms." The pituitary gland below the brain secretes hormones that signal the growths and secretions in the ovary. Later, when the ovarian secretions reach low levels, these low levels stimulate the pituitary gland to secrete more hormones, which stimulate the development of another egg.

Objectives

In this activity you will:

1. Examine the events that occur in a 28-day menstrual cycle.
2. Graph the changing levels of four hormones in the bloodstream.
3. Study how hormone feedback mechanisms control a cyclic function.

Procedures and Observations

PART I. THE FOLLICULAR PHASE

1. Look at Figure 1. Notice that it is made up of four parts—A, B, C, and D. Parts B and D show events occurring during the menstrual cycle. Parts A and C are graphs, which you will complete, that show the levels of hormones secreted during the menstrual cycle. Notice that each graph has two different y-axes. Each y-axis will be used to plot the level of a different hormone.

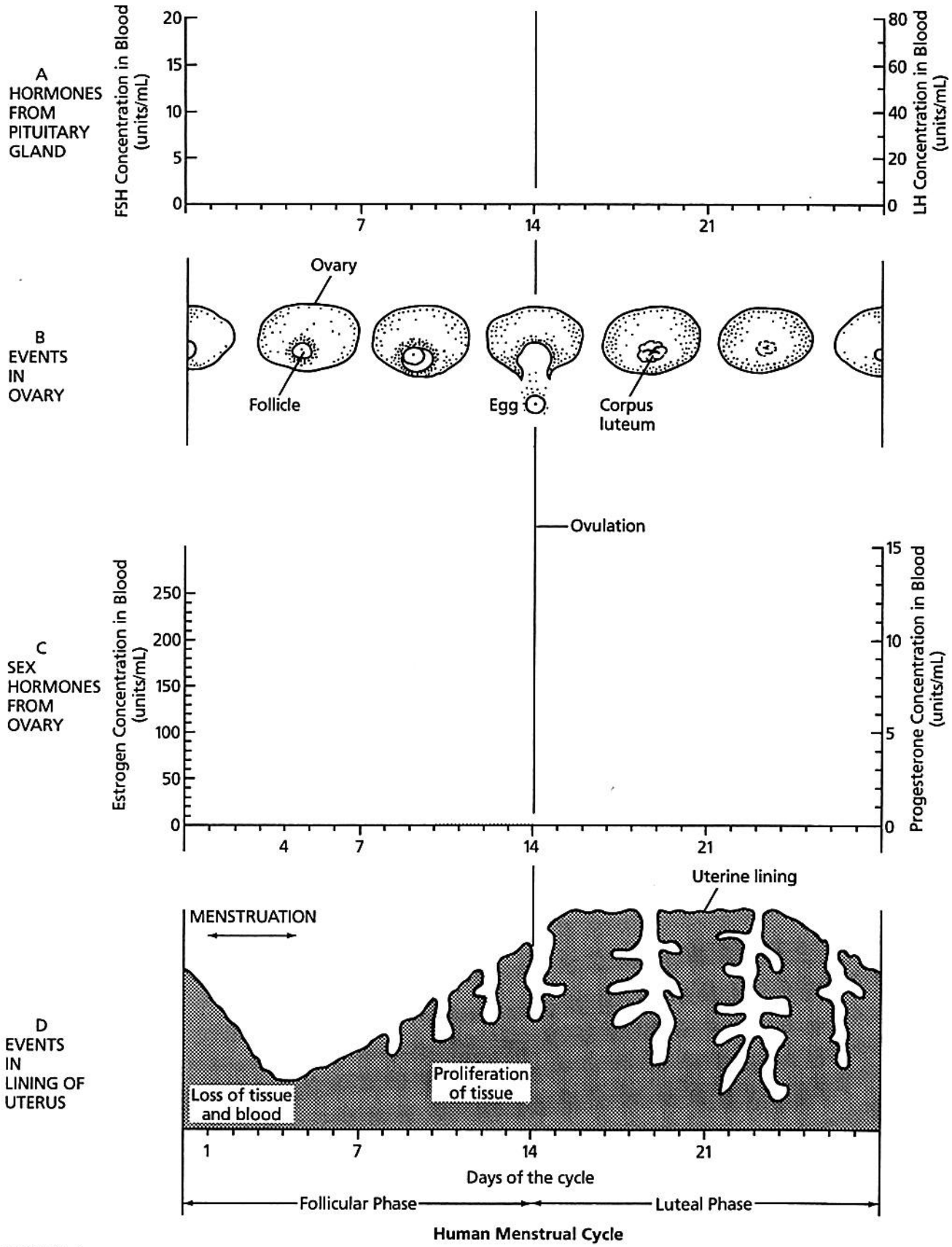
A
HORMONES
FROM
PITUITARY
GLAND
FSH Concentration in Blood (units/mL)
LH Concentration in Blood (units/mL)
20
15
10
5
0
80
60
40
20
0
7
14
21
B
EVENTS
IN
OVARY
Ovary
Follicle
Egg
Corpus luteum
Ovulation
C
SEX
HORMONES
FROM
OVARY
Estrogen Concentration in Blood (units/mL)
Progesterone Concentration in Blood (units/mL)
250
200
150
100
50
0
15
10
5
0
4
7
14
21
D
EVENTS
IN
LINING OF
UTERUS
Uterine lining
MENSTRUATION
Loss of tissue and blood
Proliferation of tissue
1
7
14
21
Days of the cycle
Follicular Phase
Luteal Phase
Human Menstrual Cycle

FIGURE 1

Name _____

The Human Menstrual Cycle (continued)

31

Inside the follicle of the ovary is a single maturing egg, or ovum. On day 1 of a cycle, the follicle of a new egg is about to be stimulated to grow by an increase in the amount of follicle-stimulating hormone (FSH) in the blood. FSH is secreted by the pituitary gland.

2. Using the data in Table 1 on page 176, plot points in Part A of Figure 1 to indicate the concentrations of follicle-stimulating hormone in the blood. Remember to use the left-hand vertical axis. Check the points, then use a pencil to draw a curve. (Do not "connect the dots." Draw a smooth curve.)
   a. *On what day does follicle-stimulating hormone reach maximum concentration?*

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   b. *What happens to the follicle during the 14 days that you plotted in Step 2, above? What causes these changes?*

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The growing follicle secretes *estrogen,* a sex hormone, in increasing amounts. By the 13th day, the concentration of estrogen has increased to the point that it causes FSH secretion to decrease.

3. In Part C, use the data in Table 1 to plot points indicating concentrations of estrogen in the blood. Use the left-hand vertical axis for this plot. Draw a curve for the estrogen, as you did for follicle-stimulating hormone in Step 2.

The increased estrogen in the blood stimulates the cells of the uterus to form new tissue containing capillaries. In this way, the uterus is prepared for the arrival of an embryo.

4. Look at Part D of Figure 1. Notice that during menstruation the lining of the uterus decreases; between days 5 and 15, the lining reforms.
   c. *What happens in the ovary (Part B) and in the bloodstream (Part C) that brings about this change in the uterus?*

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The increased concentration of estrogen that occurs during the follicular phase also stimulates the secretion of another pituitary hormone,

luteinizing hormone (LH). By day 14 or 15, ovulation has occurred, and luteinizing hormone has reached its highest concentration.

5. On Part A of Figure 1, plot the points indicating the concentrations of LH for days 1–14. See Table 1 for data. Remember to use the right-hand vertical axis. Check the points, then draw the curve showing the changes in concentration of luteinizing hormone, or LH.

   d. *On what day of the cycle does luteinizing hormone reach maximum concentration?*

By the 14th day, the egg has developed sufficiently for fertilization to be possible. Ovulation occurs at some time between the 10th and 15th days. Ovulation ends the follicular phase.

PART II. THE LUTEAL PHASE

During the luteal phase, the ruptured follicle that remains in the ovary is stimulated by luteinizing hormone. The follicle grows and becomes a hollow, yellow mass of tissue called the *corpus luteum* ("yellow body"). The corpus luteum acts as an endocrine gland, secreting the hormone *progesterone*. Progesterone stimulates the uterus to maintain its thickened lining, and to develop pockets that contain glands.

1. Find the 15th day in Part B of Figure 1. Note the changes in the follicle tissue between days 15 and 28.

By the time ovulation has occurred, the secretion of estrogen by the follicle has stopped. The decrease in estrogen concentration causes the production of luteinizing hormone to decrease. The corpus luteum then deteriorates and stops producing progesterone.

2. In Part C of Figure 1, plot points indicating the concentrations of estrogen on Days 15–28. See Table 2 for data. Draw the remainder of the curve for estrogen. Label the curve.

Table 1. Concentrations of Hormones in Blood: Follicular Phase

Units per Milliliter				
Day	FSH	Estrogen	LH	Progesterone
1	9	30	9	0.6
2	11	40	12	0.8
3	13	50	16	1.0
4	14	70	18	1.0
5	15	80	19	1.0
6	14	100	16	1.0
7	14	130	12	1.2
8	15	140	19	1.2
9	13	180	15	1.3
10	11	200	16	1.5
11	9	220	20	1.5
12	18	230	30	1.6
13	13	220	75	1.8
14	9	200	58	2.0

Table 2. Concentrations of Hormones in Blood: Luteal Phase

Units per Milliliter				
Day	FSH	Estrogen	LH	Progesterone
15	9	180	30	2.3
16	8	150	14	3.7
17	8	120	10	5.8
18	8	100	9	8.3
19	8	50	7	10.4
20	7	30	5	12.0
21	7	25	3	12.0
22	6	25	3	11.8
23	5	25	2	10.3
24	5	25	3	7.2
25	6	20	3	4.0
26	7	20	4	3.0
27	7	25	5	1.5
28	8	25	7	0.8

Name _____

3. In Part A of Figure 1, plot data from Table 2 to show concentrations of luteinizing hormone on days 15–28. Draw and label the curve for luteinizing hormone.
4. In Part C of Figure 1, plot points indicating the concentrations of progesterone for the entire 28-day cycle. Obtain data from both Table 1 and Table 2. Use the right-hand vertical axis for this plot. Draw and label the curve.

If an embryo becomes embedded in the uterine wall, the new glandular pockets will be stimulated to secrete hormones similar to progesterone and estrogen, and the uterine lining will be maintained all through the pregnancy.

If no embryo arrives in the uterus, the concentration of progesterone in the blood decreases rapidly. By day 28, both estrogen and progesterone in the blood are at their lowest combined levels. This condition signals the onset of menstruation—the end of the current cycle and the beginning of the next.

Since the secretion of *follicle-stimulating hormone* (FSH) is also triggered by simultaneously low concentrations of estrogen and progesterone, a new follicle will be stimulated to develop only when the ovarian hormones are both at very low levels of concentration in the blood.

5. In Part A of Figure 1, plot points for the concentrations of follicle-stimulating hormone on days 15–28. Data are given in Table 2. Draw and label the curve.
   a. *Why does the level of follicle-stimulating hormone decrease and remain at a relatively low level during the luteal phase of the cycle?*

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Analysis and Interpretations

1. What process signals the end of one cycle and the beginning of another?

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2. Why are the interactions of hormones and tissues in the menstrual cycle considered to be feedback mechanisms?

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3. How does estrogen play a role in a feedback mechanism?

4. How does progesterone play a role in a feedback mechanism?