

LAB _____. STAGES OF THE HUMAN MENSTRUAL CYCLE

When a human female is born, her ovaries already contain all the immature eggs that will later mature and produce functional eggs during her lifetime. Eggs usually begin to mature between the ages of 12 and 14, when a release of hormones triggers **puberty** and a young woman reaches sexual maturity. Most commonly, eggs mature every 28 days or so. They usually mature one at a time, in alternating ovaries. This rhythmic maturation of eggs and the other chemical and physical events that accompany the process are called the **menstrual cycle**.

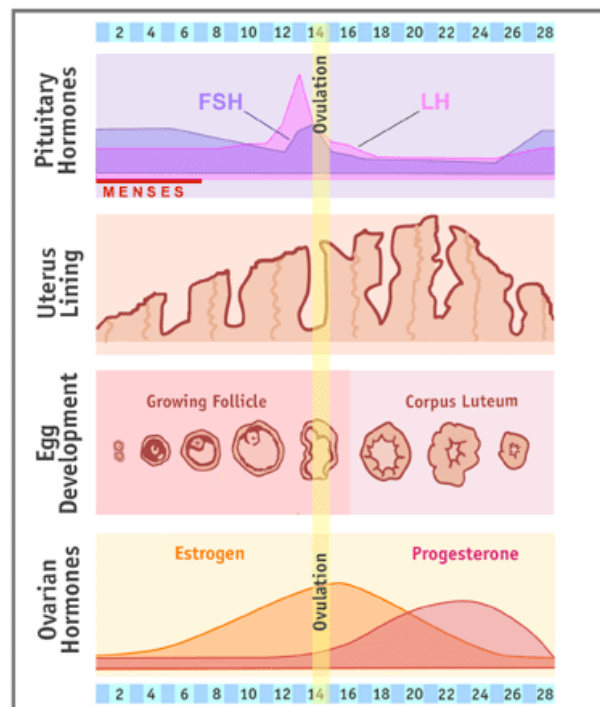
As a reaction to increasing levels of the hormone **FSH (follicle stimulating hormone)** eggs start to mature in a woman's ovary. Each egg matures inside an egg sac, or **follicle**, near the surface of one of the ovaries. When the egg is fully mature, another hormone — **LH (luteinizing hormone)** — reaches peak level. As a reaction to these high hormone levels, the follicle bursts open and releases the egg. This process is called **ovulation**. Tiny microscopic hairs, called cilia, on the cells at the opening to the **Fallopian tube** or **oviduct**, sweep the egg into the tube which leads to the **uterus**.

As a reaction to increasing levels of the hormone **estrogen**, the lining of the uterus has been prepared to receive a fertilized egg by building up its lining with nurturing tissues and blood vessels.

After the egg is released from the follicle in the ovary, the remaining follicle tissue becomes a hormone secreting gland, the **corpus luteum** ("yellow body"). The gland releases the hormone **progesterone**. High levels of progesterone help maintain the uterine in its built up, nurturing phase.

If the released egg remains unfertilized, it does not implant in the uterus lining. This triggers further hormonal changes. Both estrogen levels and progesterone levels drop. This causes the lining of the uterus to deteriorate. As a result both unfertilized egg and uterus lining are shed and pass out of the body. This periodic loss of tissues and fluids from the uterus is a normal function known as **menstruation** (a period). Menstruation is considered the beginning of the monthly menstrual cycle.

All of these changes are governed by coordinated hormones carried in the bloodstream from their releasing gland to their responding target cells. These hormones act through **feedback mechanisms**. The pituitary gland, at the base of the brain, secretes the two hormones that trigger the growth and development of the egg in the ovary — **FSH (follicle stimulating hormone)** and **LH (luteinizing hormone)**. In response, the ovary then secretes the two sex hormones that control development of the egg and uterus lining — **estrogen** and **progesterone**. When ovarian hormones reach low levels, this "feeds back" and stimulates the pituitary gland to once again secrete its hormones to stimulate the development of another egg for another cycle.



INSTRUCTIONS**Part A. Hormones of the Menstrual Cycle and Their Effects**

1. Look at the charts of Figure 1. Notice that there are four charts and each chart has an X-axis and Y-axis like a graph.
 - A. Hormones from the Pituitary Gland in the Brain
 - B. Events in Ovary (Egg Development)
 - C. Sex Hormones from the Ovary
 - D. Events in the Lining of the Uterus
2. **FSH**: Using the data in Table 1, plot the points in **Chart A** to track the concentrations of **FSH** (follicle-stimulating hormone) released by the pituitary gland into the blood. Be sure to use the left-hand scale on the graph. Draw a smooth curve rather than just connecting the dots. Answer Question 1 "**Part A: FSH Questions**" at the back of this packet.
3. **Estrogen**: Using the data in Table 1, plot the points in **Chart C** to track the concentrations of **estrogen** released by the ovary into the blood. Be sure to use the left-hand scale on the graph. Draw a smooth curve rather than just connecting the dots. Answer Question 2 "**Part A: Estrogen Questions**" at the back of this packet.
4. **LH**: Using the data in Table 1, plot the points in **Chart A** to track the concentrations of **LH** (luteinizing hormone) released by the pituitary gland into the blood. Be sure to use the right-hand scale on the graph. Draw a smooth curve rather than just connecting the dots. Answer Question 3 "**Part A: LH Questions**" at the back of this packet.
5. **Progesterone**: Using the data in Table 1, plot the points in **Chart C** to track the concentrations of **progesterone** released by the ovary into the blood. Be sure to use the right-hand scale on the graph. Draw a smooth curve rather than just connecting the dots. Answer Question 4 "**Part A: Progesterone Questions**" at the back of this packet.

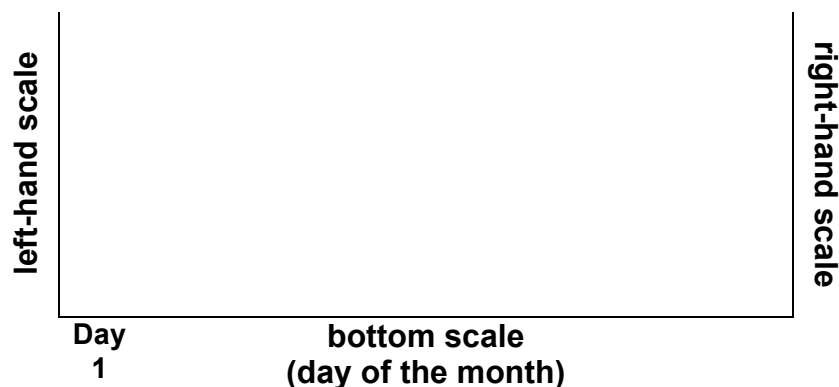


TABLE 1. HORMONES OF THE HUMAN MENSTRUAL CYCLE

| 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 |
| 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 |

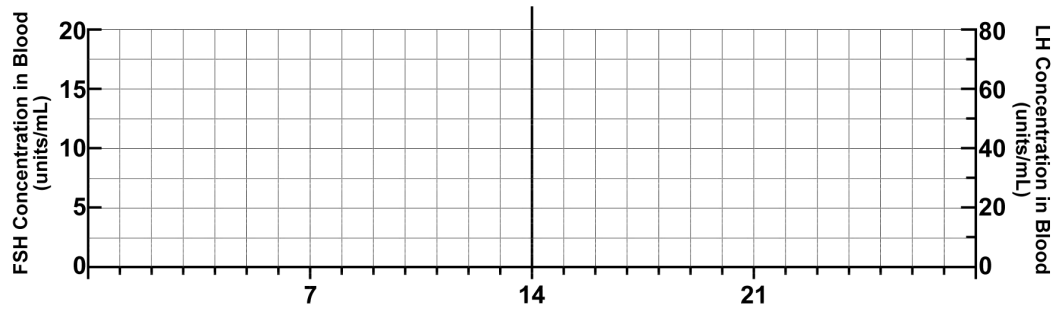
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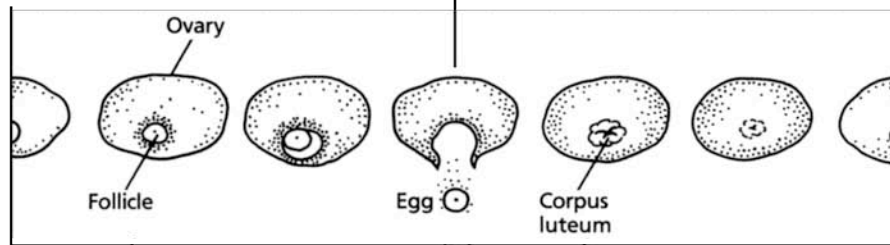
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FIGURE 1.

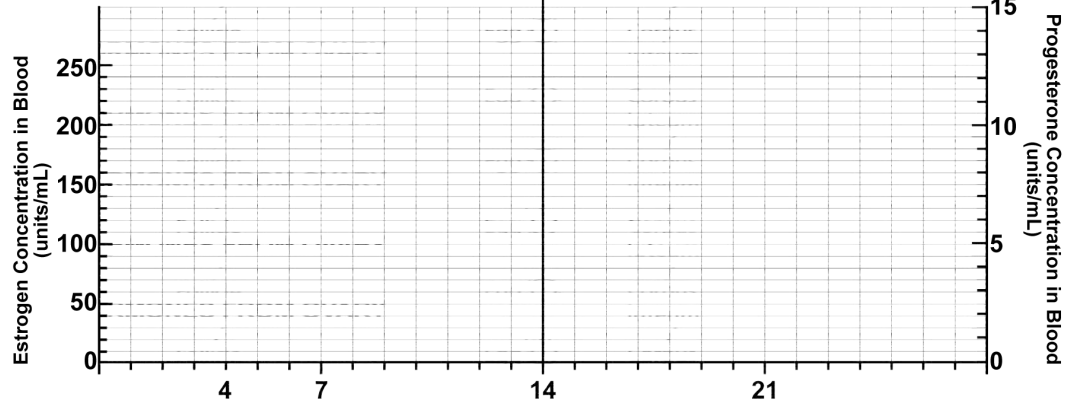
A. HORMONES FROM THE PITUITARY



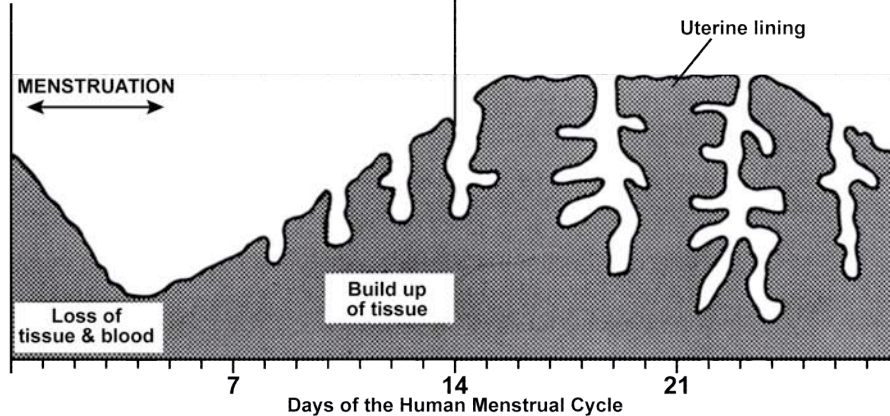
B. EVENTS IN OVARY



C. SEX HORMONES FROM OVARY

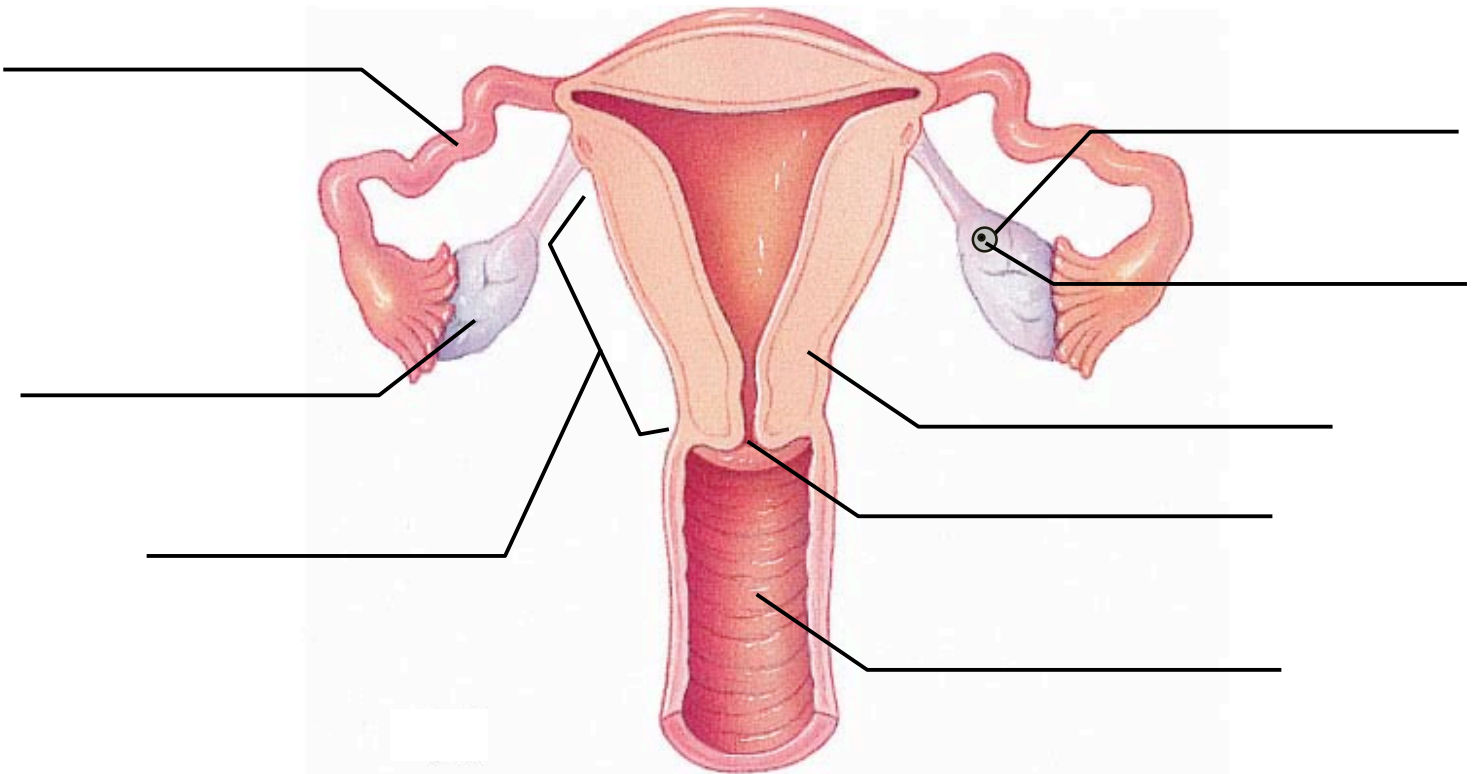


D. EVENTS IN LINING OF UTERUS



PART B. ANATOMY

1. Review the anatomy of the human female reproductive system.
2. Label the diagram below with the following terms:
 - a. **ovary**: the female reproductive organ in which eggs are produced. It also acts as a gland and secretes estrogen and progesterone sex hormones.
 - b. **uterus** (womb): the muscular organ in which a fetus develops and is nurtured during pregnancy.
 - c. **uterus lining**: the inner tissue in the uterus which builds up in preparation for the implantation of a fertilized egg. It is rich in blood vessels to nurture the embryo.
 - d. **egg** (ovum): female sex cell with one copy of the mother's genes.
 - e. **Fallopian tube** (oviduct): two very thin tubes that serve as a path for the egg from the ovaries to the uterus.
 - f. **vagina**: muscular tube that serves as the birth canal for delivering the baby from the uterus (womb) to the outside world.
 - g. **follicle**: tissue in ovary surrounding developing egg. The follicle cells are the cells of the ovary that secrete the hormone, estrogen.
 - h. **cervix**: opening of the uterus that leads to the vagina. During birth, the cervix must dilate enough (up to 10 cm or ~4 inches) to allow the baby to pass through.



Part C. The Calendar of the Menstrual Cycle

In this section we will explore the events of the menstrual cycle across a calendar month to relate the internal stages of the menstrual cycle to the days of the month.

1. Menstrual Cycle: No Fertilization of Egg

1. At the back of this packet you will find a series of symbols in squares labeled **Figure 2A**. “No Fertilization of Egg”. These diagrams show different stages that occur during the menstrual cycle if fertilization **does not** occur.
2. Look over the calendar marked Figure 2B. It describes the series of events that take place in the female reproductive system if fertilization **does not** occur.
3. Cut out the squares from Figure 2A and match them with the events on the calendar. Place the square to the right of the bracket (in an *empty* day) for the event that properly describes it.
Note: *Not all calendar boxes will be filled in.*
4. When all squares have been properly matched to events, tape them onto the calendar in their proper location.

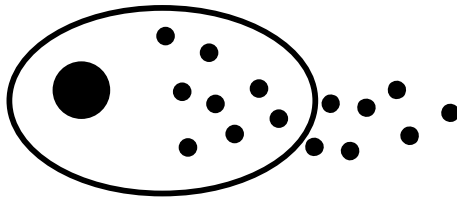
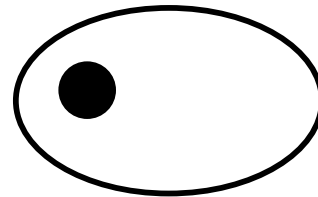
2. Menstrual Cycle: Fertilization of Egg Does Occur

1. At the back of this packet you will find a series of symbols in squares labeled **Figure 3A**. “Fertilization of Egg”. These diagrams show different stages that occur during the menstrual cycle if fertilization **does** occur.
2. Look over the calendar marked Figure 3B. It describes the series of events that take place in the female reproductive system if fertilization **does** occur.
3. Cut out the squares from Figure 3A and match them with the events on the calendar. Place the square to the right of the bracket (in an *empty* day) for the event that properly describes it.
Note: *Not all calendar boxes will be filled in.*
4. When all squares have been properly matched to events, tape them onto the calendar in their proper location.

SUMMARY QUESTIONS**1. Part A: FSH questions**

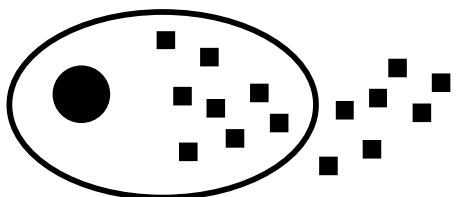
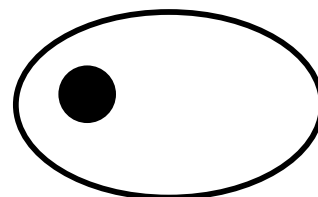
- a. What gland secretes FSH (follicle-stimulating hormone)? _____
- b. On what day does the FSH reach its peak concentration? _____
- c. What happens to the egg follicle in the ovary as FSH rises (during Days 1-12)?

- d. If the picture below is illustrating a cell secreting FSH, then draw what the receptors would look like on the target cell in the ovary.

**SECRETING CELL****TARGET CELL****2. Part A: Estrogen questions**

- a. What gland secretes estrogen? _____
- b. On what day does the estrogen reach its peak concentration? _____
- c. What happens to the uterus lining during days 1-12 days, as estrogen is rising?

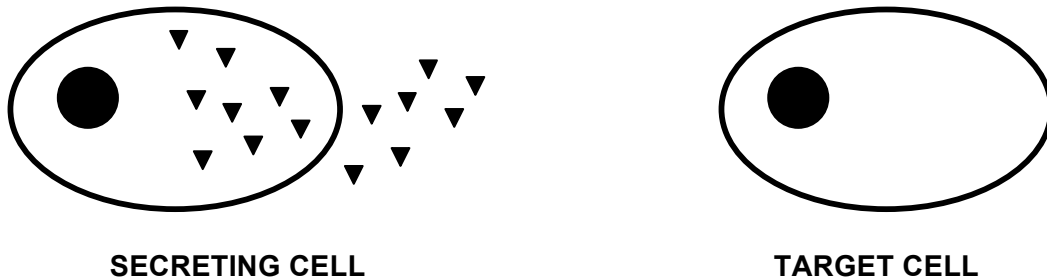
- d. If the picture below is illustrating a cell secreting estrogen, then draw what the receptors would look like on the target cell in the uterus.

**SECRETING CELL****TARGET CELL**

3. Part A: LH questions

- a. What gland secretes LH (luteinizing hormone)? _____
- b. On what day does the LH reach its peak concentration? _____
- c. What happens to the egg in the ovary on Day 14 after LH levels reach their peak?

- d. If the picture below is illustrating a cell secreting LH, then draw what the receptors would look like on the target cell in the ovary.

**4. Part A: Progesterone questions**

- a. On Day 14 the egg is released (ovulation). After that the corpus luteum forms in the remaining follicle and it starts releasing progesterone. On what day does the progesterone reach its peak concentration? _____
- b. While progesterone stays at a high level what happens to the lining of the uterus?

- c. If the woman does not get pregnant, then the corpus luteum breaks down and the level of progesterone starts declining. Once progesterone decreases what happens to the lining of the uterus?

- d. On the "Events in Lining of Uterus" chart, what process is occurring between Days 3 – 6? _____

5. **Part B & C Questions: Explain the role of the following structures:**

a. ovary _____

b. follicle _____

c. fallopian tube _____

d. uterus _____

e. uterus lining _____

f. cervix _____

6. The average menstrual cycle with no fertilization takes how many days? _____

7. Describe the changes that take place during the menstrual cycle from Day 1-4 to the following:

a. unfertilized egg in ovary _____

b. uterus lining _____

8. Describe the changes that take place during the menstrual cycle from Day 5-13 to the following:

a. unfertilized egg in ovary _____

b. uterus lining _____

9. Describe what happens to the egg during the menstrual cycle on Day 14.

10. Describe the changes that take place to an egg...

a. from Day 15-28, if no fertilization occurs _____

b. from Day 15-21, if fertilization does occur. _____

c. from Day 21-266, if fertilization does occur. _____

11. Explain why the female...

a. needs a thick uterus lining if fertilization does occur. _____

b. no longer needs a thick uterus lining if fertilization does not occur. _____

12. At what time during a woman's menstrual cycle is it easiest to become pregnant?

13. Why is this whole process called a "cycle"? _____

Figure 2B. Day By Day Changes In The Menstrual Cycle: No Fertilization of Egg

| | | | | | | |
|---|--|-------------------------------------|------------------------------|---|------------------------------------|---------------------------------------|
| Cycle repeats | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Uterus lining and egg are shed during menstruation. | | New egg is maturing in ovary. | | Uterus lining is thin after blood and tissue have been lost. | | |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | Egg within ovary is almost fully mature. | | Uterus lining is thickening. | | Mature egg is released from ovary. | |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Egg is in oviduct. No sperm cells present. Egg is not fertilized. | | Uterus lining continues to thicken. | | Uterus lining is very thick. Egg moves lower in uterus. | | |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| | | Uterus lining is at its thickest. | | Lining of uterus and egg are ready to be shed. They are no longer needed. | | Go back to Day 1. Cycle starts again. |

Figure 3B. Day By Day Changes In The Menstrual Cycle: Fertilization of Egg

| | |
|---------------|-----|
| Cycle repeats | |
| 7 | |
| 6 | 14 |
| 5 | 13 |
| 4 | 12 |
| 3 | 11 |
| 2 | 10 |
| 1 | 9 |
| 8 | 15 |
| 7 | 21 |
| 6 | 20 |
| 5 | 19 |
| 4 | 18 |
| 3 | 17 |
| 2 | 16 |
| 1 | 31 |
| 266 | 265 |
| 92 | 91 |
| 90 | 90 |
| 30 | 30 |

Day 1: Uterus lining and egg are shed during menstruation.
 Day 2: }
 Day 3: New egg is maturing in ovary.
 Day 4: }
 Day 5: Uterus lining is thin after blood and tissue have been lost.
 Day 6: }
 Day 7: }
 Day 8: }
 Day 9: Egg within ovary is almost fully mature.
 Day 10: }
 Day 11: Uterus lining is thickening.
 Day 12: }
 Day 13: Mature egg is released from ovary into oviduct.
 Day 14: }
 Day 15: Sperm cells fertilize egg.
 Day 16: }
 Day 17: }
 Day 18: }
 Day 19: }
 Day 20: 6-day-old embryo buries itself in uterus lining.
 Day 21: }
 Day 265: }
 Day 266: Full term pregnancy. After birth, return to Day 3 of either calendar.
 Day 30: Uterus lining continues to thicken as embryo grows.
 Day 90: Developing embryo now considered a fetus and continues to grow.
 Day 91: }
 Day 92: }
 Day 90: }

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Figure 2A. No Fertilization of Egg

Cut out individual boxes and place on the appropriate empty date on the accompanying calendar labeled, "Figure 2B. Day By Day Changes In The Menstrual Cycle: No Fertilization of Egg".

NOTE: Do *not* paste over the days with writing in them. Paste into the empty day *next to* the correct description.

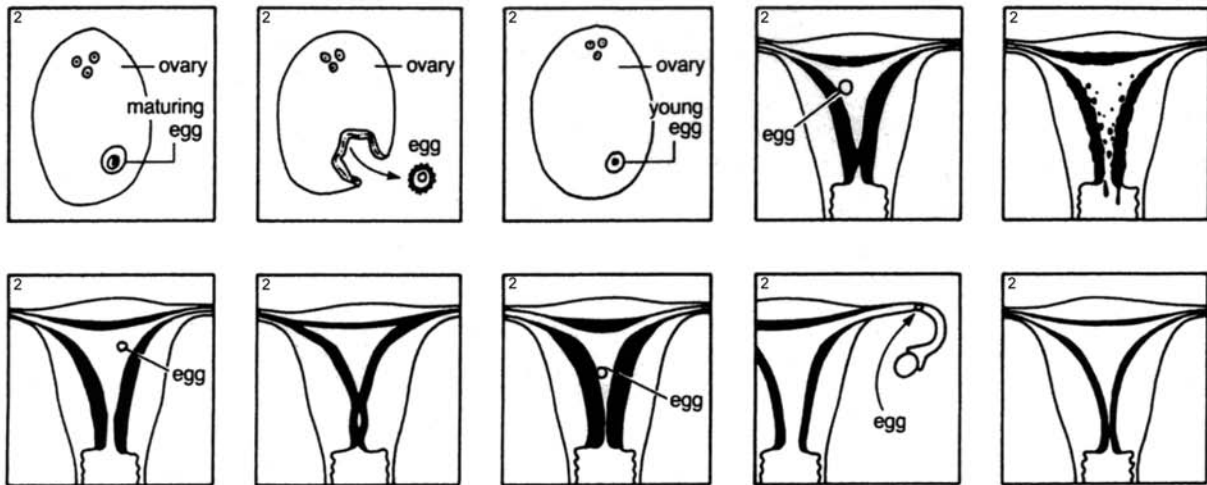


Figure 3A. Fertilization of Egg

Cut out individual boxes and place on the appropriate empty date on the accompanying calendar labeled, "Figure 3B. Day By Day Changes In The Menstrual Cycle: Fertilization of Egg".

NOTE: Do *not* paste over the days with writing in them. Paste into the empty day *next to* the correct description.

