Female Fertility – The Egg Comes First

Believe it or not, a developing female fetus actually possesses more immature reproductive cells prior to birth than the child or woman will ever possess after birth. The production of mature reproductive cells in the female occurs quite differently to that of a male—where a male will emit millions of sperm at a time, a woman will usually only produce one egg each reproductive cycle, approximately every twenty-eight days. In her lifetime, her ovaries will prepare and release only about 500 eggs for the purpose of reproduction and all the rest will die off and be reabsorbed.

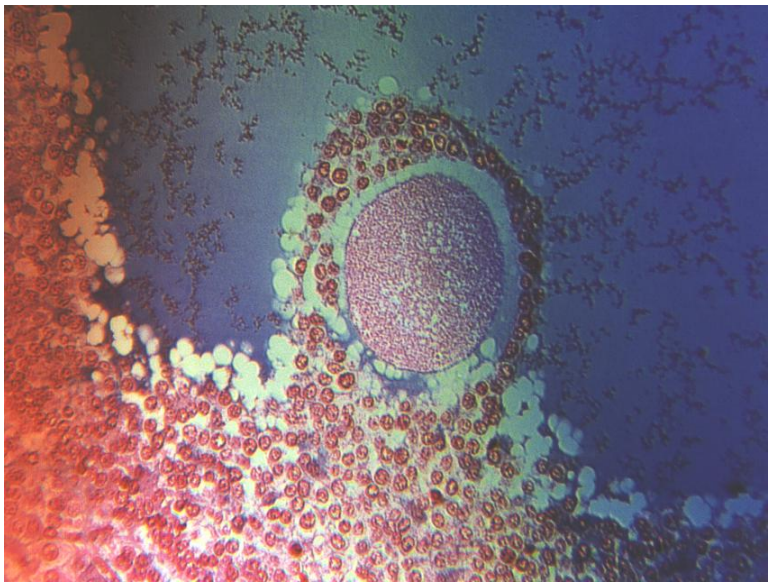

Figure 1: Egg Within The Ovary[1]

[1] The developing egg shown in figure 1 is surrounded by a group of cells that will ultimately create a protective layer around the egg and provide for its nutrition during the journey from ovary to uterus. Although it does not have as far to travel as a sperm cell, it has no means of self-propulsion and will therefore take much longer to move into the uterus, being moved along only by cilia within the uterine tubes and by the motion of fluids.

While the fetus is developing, her ovaries will contain up to three million oogonia, having developed through the process of mitosis into primary oocytes. As previously discussed, these will remain dormant after meiotic division only to the prophase stage, and only upon puberty will further development begin. At birth, perhaps only one third of the eggs remain, and by the age of puberty there are only about one hundred thousand remaining, and these continue to either be released or die off until the woman reaches menopause.[2] The cycles between puberty and menopause provide the egg and the required environment within the uterus to make reproduction a possibility.

Figure 2: Boy Meets Girl (Again)

For the purposes of explaining the reproduction cycle and how it is controlled by hormones, we'll assume the young woman has already passed through the stages of puberty and is just beginning another cycle (the ovarian cycle, menstrual cycle, and sex hormone cycle work in concert to accomplish what is known overall as the twenty-eight day female reproductive cycle). All three cycles are combined and illustrated in figure 4.

On day one when estrogen levels are at their lowest, a series of events take place. Lower levels of estrogen stimulate increased release of Gonadotropin-Releasing Hormone, or GnRH, from the hypothalamus, which in turn stimulates greater release of two hormones,

[2] At which time she may develop both a mustache and an intolerance for nearly everything while her ovaries atrophy and cease to produce eggs, estrogen, and progesterone (the supply is exhausted and so is she).

Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH), from the pituitary gland. These hormones result in an increase in estrogen production (LH) and the stimulation of follicular growth (FSH), causing estrogen levels to rise to a peak over an approximate twelve-day period.

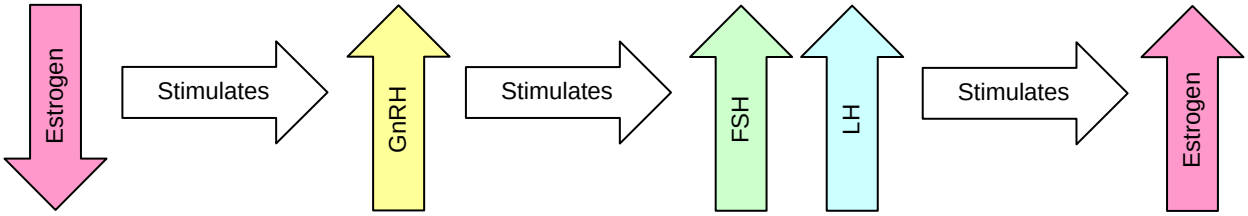

Figure 3: Estrogen During Follicular Phase

During the fourteen day length of the follicular phase of the ovarian cycle, primary follicles are stimulated, resulting in proliferation of Granulosa Cells (which form estrogen). The GCs are ultimately surrounded by Theca Cells (which will transfer estrogen from GCs to the blood stream), a fluid-filled cavity develops, and the secondary oocyte eventually results with a zona pellucida (protective shell) and a layer of follicular cells (cumulous oophorus) surrounding it—all stimulated by the increasing estrogen. At this point, the woman has a fully developed follicle, ready for rupture and release of an egg (ovulation). All the while her ovary has been busily creating a mature follicle, her uterus has been carrying on a different activity in response to the hormonal changes.

For the uterus, day one begins menstruation, during which the remnants of the previous cycle (which in this case is non-productive due to lack of fertilization), shed in the form of menstrual flow. This process lasts about five days. From the sixth to about the fourteenth day, the proliferatative phase of the menstrual cycle results in the building up of endometrial cells in the uterus in response to increases in plasma estrogen levels, thickening up to an additional 5mm with mucosa, endometrial glands, and vascular structures. Thus, the ovary is prepared for ovulation to occur, and the uterus is prepared to receive a fertilized egg.

The high levels of estrogen result in an increase in GnRH pulses, triggering a spike in LH from the pituitary gland. This causes the follicle to rupture, releasing the egg with its surrounding follicular cells and fluid-filled antrum into the peritoneal cavity, where it is then caught up in the fluid motions of the feather-like ends of the fallopian tube. After ovulation, the

presence of LH stimulates secretion of progesterone (secretory phase), and the presence of Inhibin (another hormone secreted by GCs) prevents further secretion of LSH. During this phase, the endometrial glands within the uterus secrete fluids rich in proteins and glycogen, further preparing the environment to support and sustain the egg through fertilization to eventual implantation of the embryo. Progesterone is required throughout the pregnancy to support the fetus.

If the egg is not fertilized (optimally, this should occur within the first twelve hours after ovulation, but can occur within the lifespan of the egg, which is approximately twenty-four hours), implantation will not take place. Because there will be no embryo, hCG (human chorionic gonadotropin)[3] will not be released, and it is the absence of this hormone that leads to the final phase of the menstrual cycle. During the luteal phase of the ovarian cycle, high levels of estrogen and progesterone result in an eventual decrease in FSH and LH by slowing GnRH pulsing (although it is not known exactly *how*, estrogen controls release of GnRH through negative *and* positive feedback during the ovarian cycle). Stress and illness can also affect the pattern of GnRH pulsing causing disruption to the cycle, and may affect a woman's ability to ovulate and become pregnant.

[3] hCG, in effect, sends a signal that says, "Support me, I'm a developing human!"

ID	Task Name	Start	Finish	Duration
1	**Ovarian Cycle**	**11/1/2005**	**11/28/2005**	**28d**
2	Follicular Phase	11/1/2005	11/14/2005	14d
3	Luteal Phase	11/15/2005	11/28/2005	14d
4	**Menstrual Cycle**	**11/1/2005**	**11/28/2005**	**28d**
5	Menstrual Phase	11/1/2005	11/5/2005	5d
6	Proliferative Phase	11/6/2005	11/14/2005	9d
7	Secretory Phase	11/15/2005	11/19/2005	5d
8	Ischemic Phase	11/20/2005	11/28/2005	9d

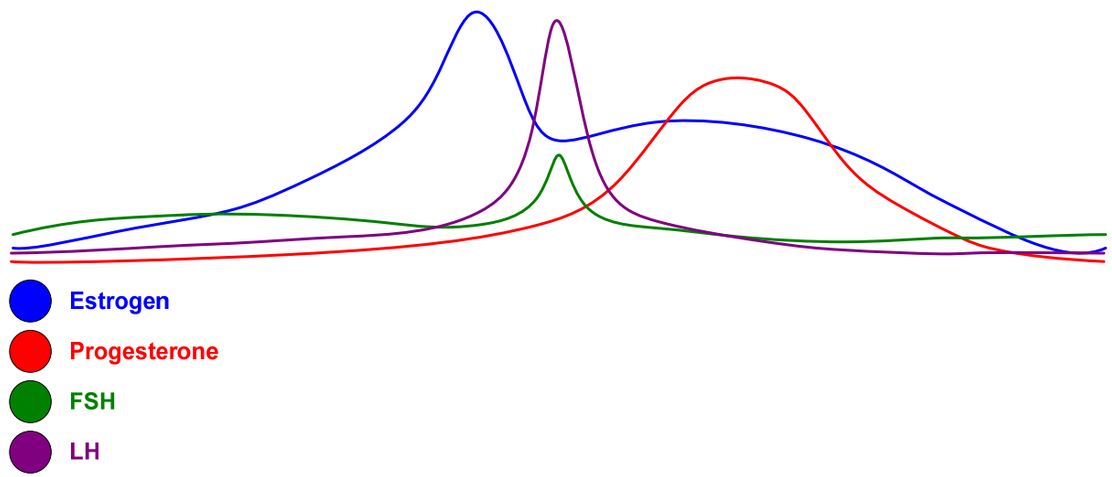

Figure 4: Ovarian-Menstrual-Hormonal Cycles Within the Human Female Reproductive Cycle

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