Hormonal cycles: fertilization and early development

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Monthly physiological changes take place in the ovaries and the uterus, regulated by hormones produced by the hypothalamus, pituitary gland and ovaries. These cycles commence at puberty and occur simultaneously and together are known as the female reproductive cycle.

The functions of the cycle are to prepare the egg often referred to as the gamete or oocyte for fertilization by the spermatozoon (sperm), and to prepare the uterus to receive and nourish the fertilized egg. If fertilization has not taken place the inner lining of the uterus or endometrium and the egg are shed and bleeding occurs per vagina, and the cyclic events begin again.
The first-ever occurrence of cyclic events is termed *menarche*, meaning the first menstrual bleeding. The average age of menarche is 12 years, although between the ages 8 and 16 is considered normal. Factors such as heredity, diet and overall health can accelerate or delay menarche. Interference with the hormonal-organ relationship during the reproductive years is likely to cause menstrual cycle dysfunction which may result in failure to ovulate.
The cessation of cyclic events is referred to as the *menopause*, and signifies the end of reproductive life. Each woman has an individual reproductive cycle that varies in length, although the average cycle is normally 28 days long, and recurs regularly from puberty to the menopause except when pregnancy intervenes.
Ovarian Cycle

The ovarian cycle consists of three phases all phases work under control of hormones

Phase I

The follicular phase

Formation of oogenia in the germinal epithelium of the ovary known as oogenesis. The preimordial germs cell differentiate into oogenia in the ovary during fetal life. Some germ cell develop into primary oocyte and enter the prophase of meiosis I cell division. Further meiosis and secondary oocyte will not develop until fertilization occurs.
The fetus female ovary contain up to 2 million primary oocytes in each ovary at birth and due to atresia the number decrease to approximately 40,000 at puberty 400 of these will mature and ovulate during woman lifetime.
1. Hypothalamus releases GnRH
2. Release of GnRH triggers anterior pituitary gland to release FSH and LH
   - FSH - responsible for the maturation of ovum and follicle formation.
     - Causes an increase in estrogen
   - LH – triggers ovulation and growth of uterine lining
- FSH activates primordial follicles to mature.
- Primordial follicles start producing follicular fluid that is HIGH IN ESTROGEN (estradiol) and some progesterone
- Primordial follicles propelled toward the surface of ovary and is now called **Graafian Follicle**.

**Graafian follicle undergoes cell division (mitosis, meiosis)**

- GF divides into:
  - a primary oocyte – with more cytoplasm
  - secondary oocyte – with less cytoplasm
- GF after meiosis contain haploid cells (23 chromosomes)
- Upsurge in LH causes the release of prostaglandin
- Prostaglandin causes the rupture of GF releasing ovum and follicular
- Increase in LH causes production of Lutein (bright yellow fluid, High in Progesterone)
- Follicle becomes “Corpus luteum”
Ovulation is the process whereby the dominant graafian follicle ruptures & discharges the secondary oocyte into the pelvic cavity.

High estrogen level cause sudden surge in LH around the day 12-14 of 28 day cycle, which last for approximately 48 hours.
Phase II
The luteal phase

This is the process by which the cell of rupture follicle proliferate and form the yellow body known as corpus luteum. This corpus luteum produce estrogen, relaxin, progesterone for 2 weeks to develop the endometrium.
Most of menstrual period last from 3-6 days most of the blood loss happens during the first 3 days. This is also when you might have cramping pain in your pelvis, legs, and back. Cramps can range from mild to severe. The cramping is your uterus contracting, helping the endometrium shed. In general, any premenstrual symptoms that you've felt before your period will go away during these first days of your cycle.
Physiology of menstruation

1st PHASE: proliferative

High levels of oestrogen causes thickening and proliferation of endometrium

- LH is increased, Oestrogen is increased
2nd PHASE: Secretory

- Increased levels of progesterone causes glands at endometrium to become rich & dilated with quantities of glycogen and other nutrient substances.

- Increased in capillaries making endometrium appear like a rich spongy velvet

- Decreased LH, Increased Progesterone
3rd phase: ischemic

- Decreased estrogen and progesterone levels causes the degeneration of the endometrium.
- Capillaries rupture, endometrium sloughs off
- 4th phase: menses/menstrual flow
  - Menses is composed of:
    - Blood from the ruptured capillaries
    - Mucin from glands
    - Fragments of endometrial tissue
    - Microscopic, atrophied, unfertilized ovum
- Total blood loss: **30-80ml**
- Iron loss: 11mg
1\textsuperscript{st} half of the cycle
- Hormones decreased
- Mucus thick and scanty
- Poor sperm survival

Ovulation
- Estrogen is increased
- Cervical mucus thin and copious
- Excellent sperm survival

2\textsuperscript{nd} half
- Decreased progesterone level
- Mucus is thick
- Poor sperm survival
Fertilization

- Contact of sperm & secondary oocyte occurs in uterine tube
  - Sperm penetration
  - Oocyte completes meiosis II
  - Nuclear fusion
Fertilization

- Sperm penetration
- Why so many?
Fertilization

- Oocyte completes meiosis II
- Nuclear fusion
Early Development

- Cleavage in uterine tube
Early Development

- **Implantation**
  - 6-7 days after fertilization
  - Trophoblast forms placenta
  - “Inner cell mass” forms embryo
Early Development

- Implantation
  - Trophoblast forms placenta
  - “Inner cell mass” forms embryo
Early Development

- Placenta
  - Provides large area for exchange of O$_2$, CO$_2$, nutrients, metabolic wastes between fetal and maternal blood
Pregnancy

- Pregnancy lasts 39-40 weeks,
  - 280 days from last menstrual period
  - 3 trimesters
- Hormonal changes
Thank you 😊