GAMETOGENESIS
&
FEMALE CYCLES

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OBJECTIVES

- ***By the end of the lecture, the students should be able to:***
- **Define gametogenesis.**
- **Differentiate the types of gametogenesis.**
- **Describe the process of spermatogenesis.**
- **Describe the process of oogenesis.**
- **Describe the female cycles (Ovarian & Uterine).**

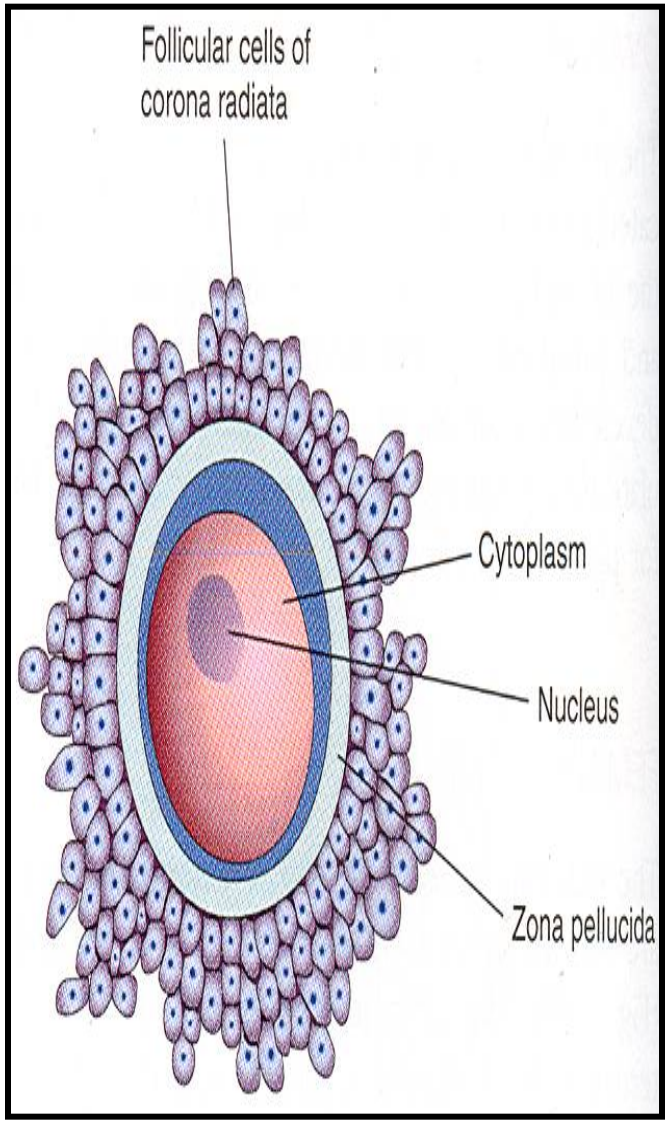
- The sustenance of any species is dependent on its ability to reproduce.
- While some organisms replicate via asexual reproduction, humans and other mammals are dependent on sexual reproduction for the propagation of their species.
- In order for their genetic code to be passed on from parents to their offspring, specialized sex cells are produced to facilitate this process.

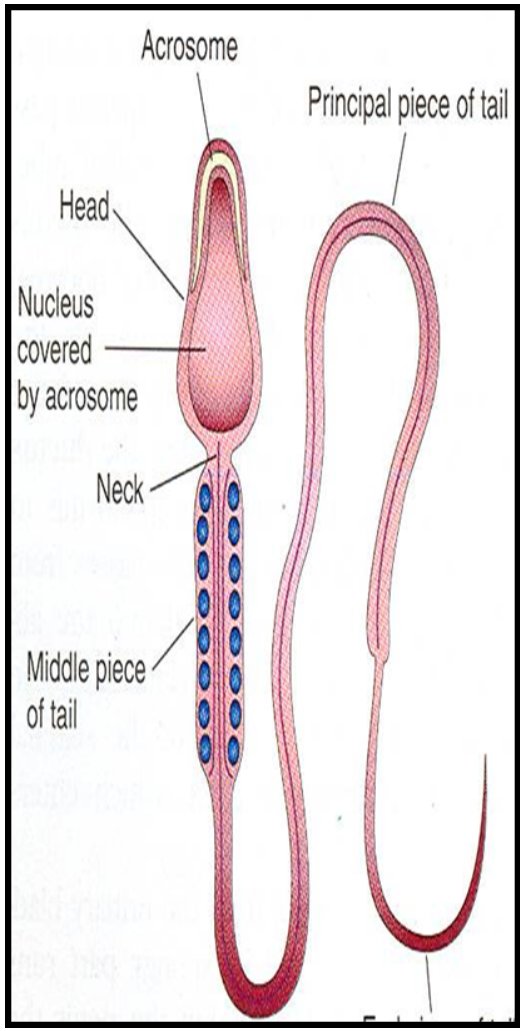
What is gametogenesis

- Gametogenesis is a complicated process that involves numerous biochemical pathways and morphological changes.
- These sex cells are produced by a specialized type of cell replication known as meiosis.
- The subsequent gametes contain half the genetic information as their parent cells, and are also unique when compared with both the parent cells and among each other.

GAMETOGENESIS

It is a complicated process involves numerous biochemical pathways and morphological changes for the formation and development of specialized generative cells, known as gametes; sex cells, Sperms for males ,and Ova for females.





- It involves the chromosomes and the cytoplasm of the gametes, preparing them for fertilization.
- These sex cells are produced by a specialized type of cell replication known as meiosis that occurs during gametogenesis
- During gametogenesis the gametes contain half the number of chromosomes (haploid number) that is present in the somatic cells

GAMETOGENESIS

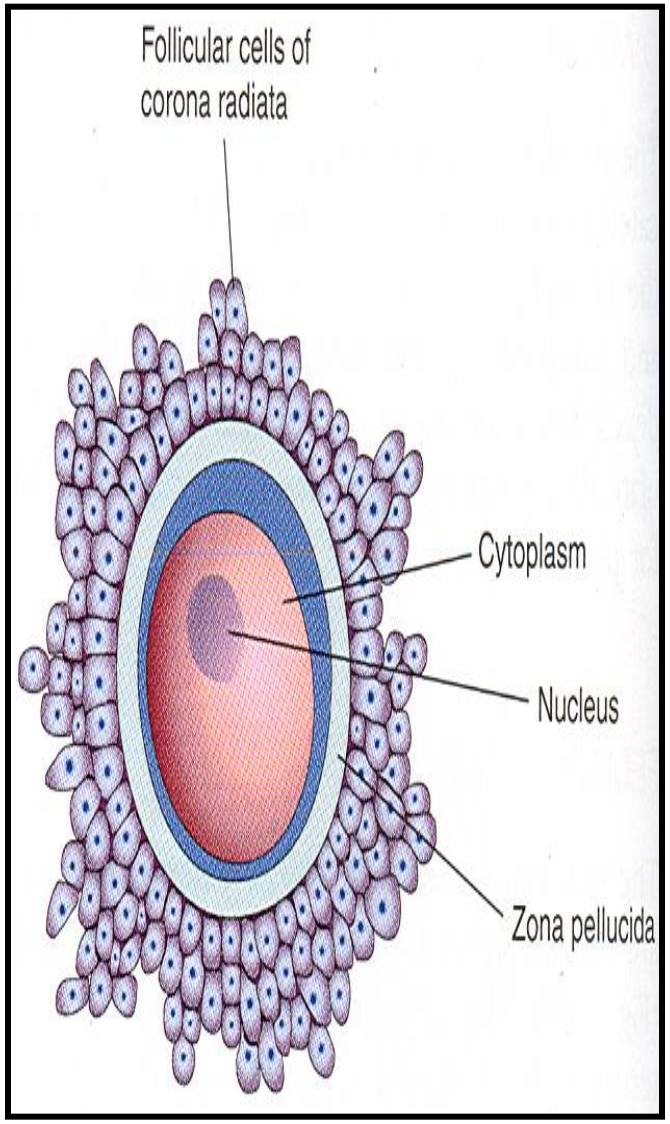
Types:

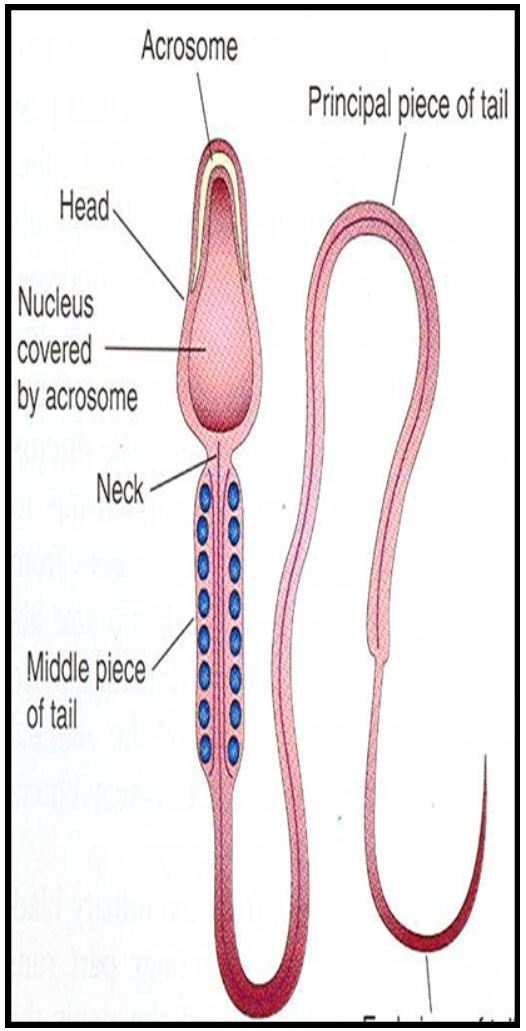
Spermatogenesis:

It is the series of changes by which the primitive germ cells (spermatogonia) are transformed into *mature sperms.*

Oogenesis:

It is the series of changes by which the primitive germ cells (oogonia) are transformed into *mature oocytes.*

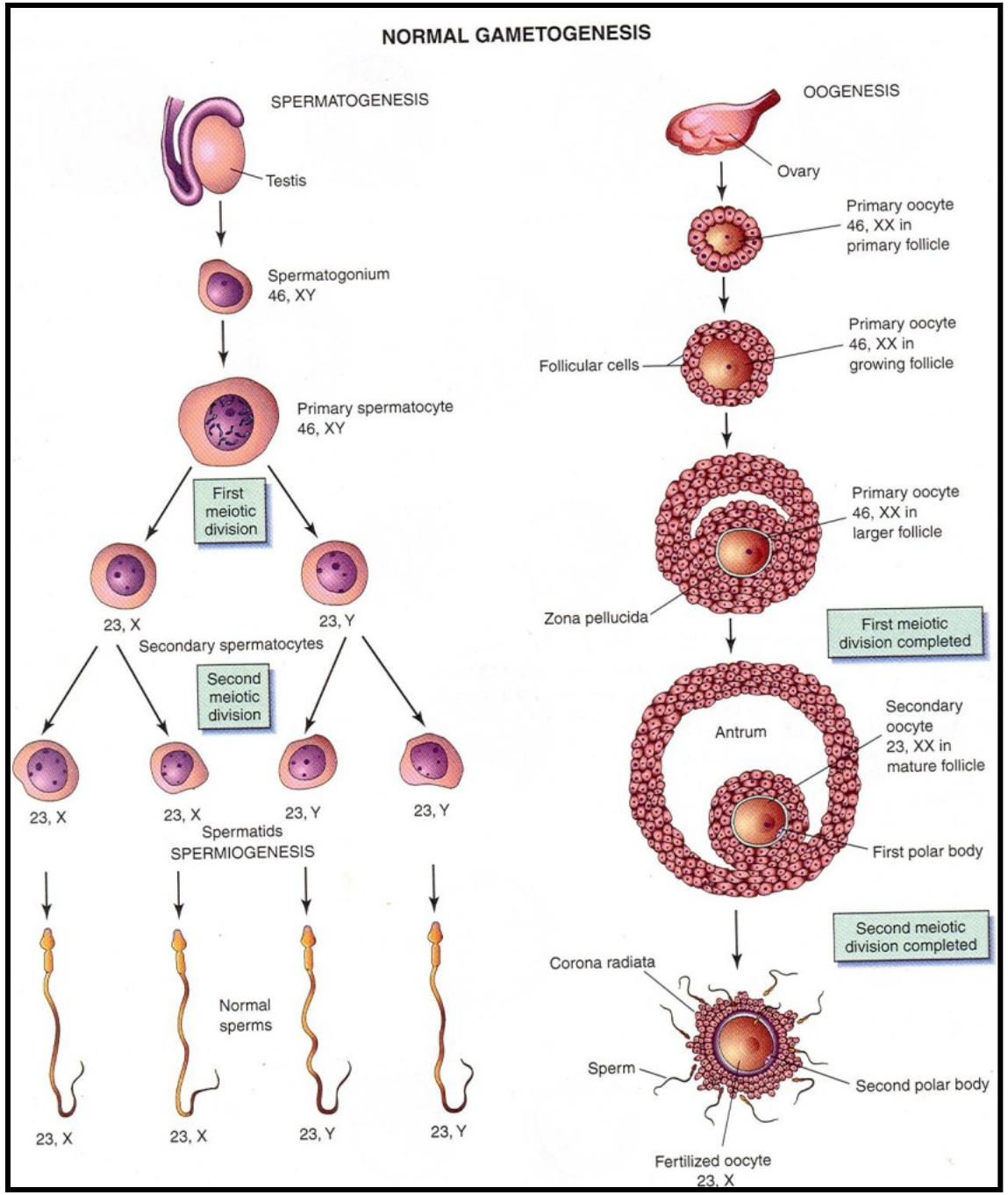




MEIOSIS

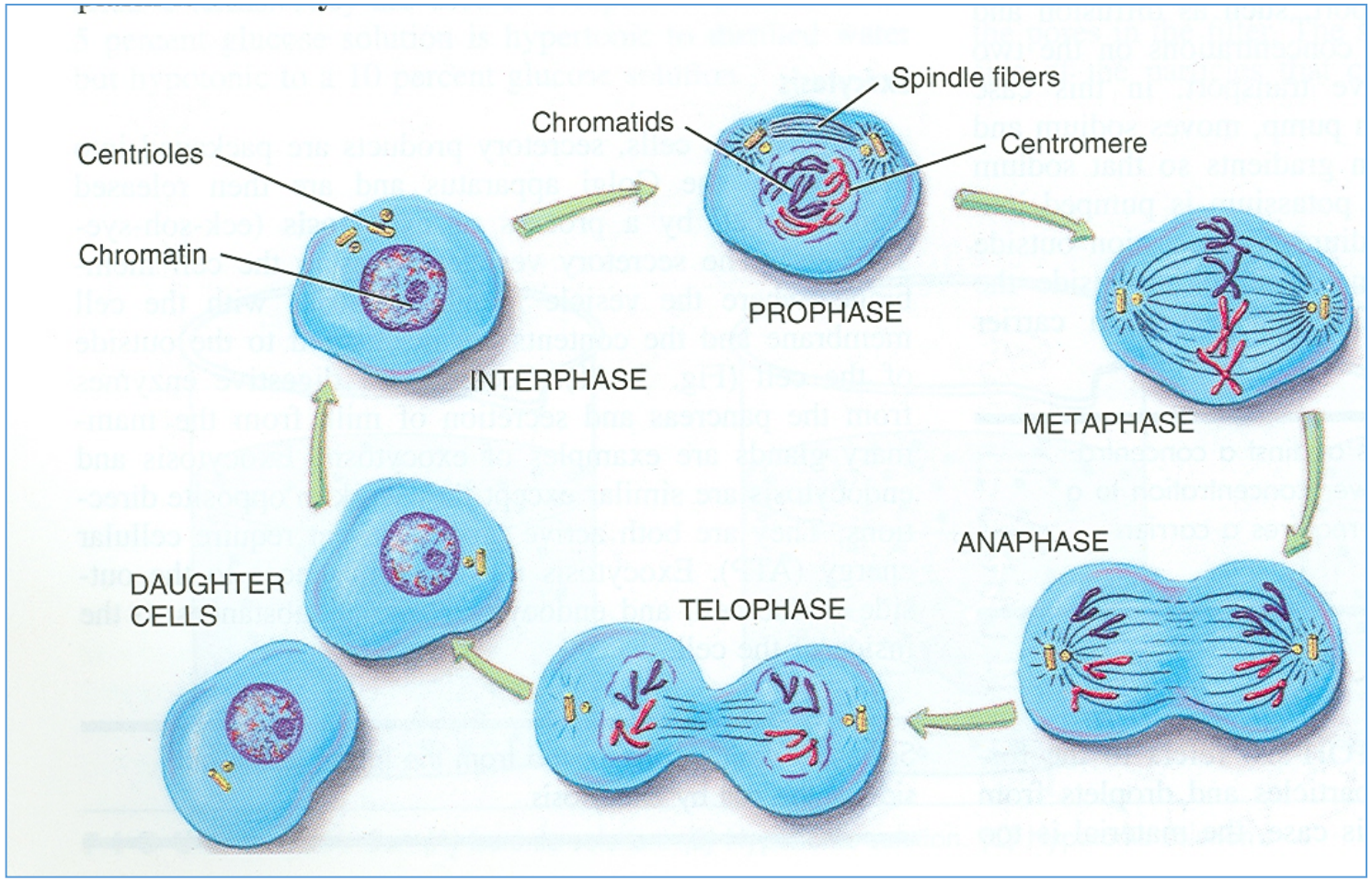
It is the cell division **(reduction division),** that takes place in the germ cells only.

It consists of two cell divisions, first meiotic division & second meiotic division during which the Diploid germ cells gives rise to haploid gametes (Sperms, Oocytes).



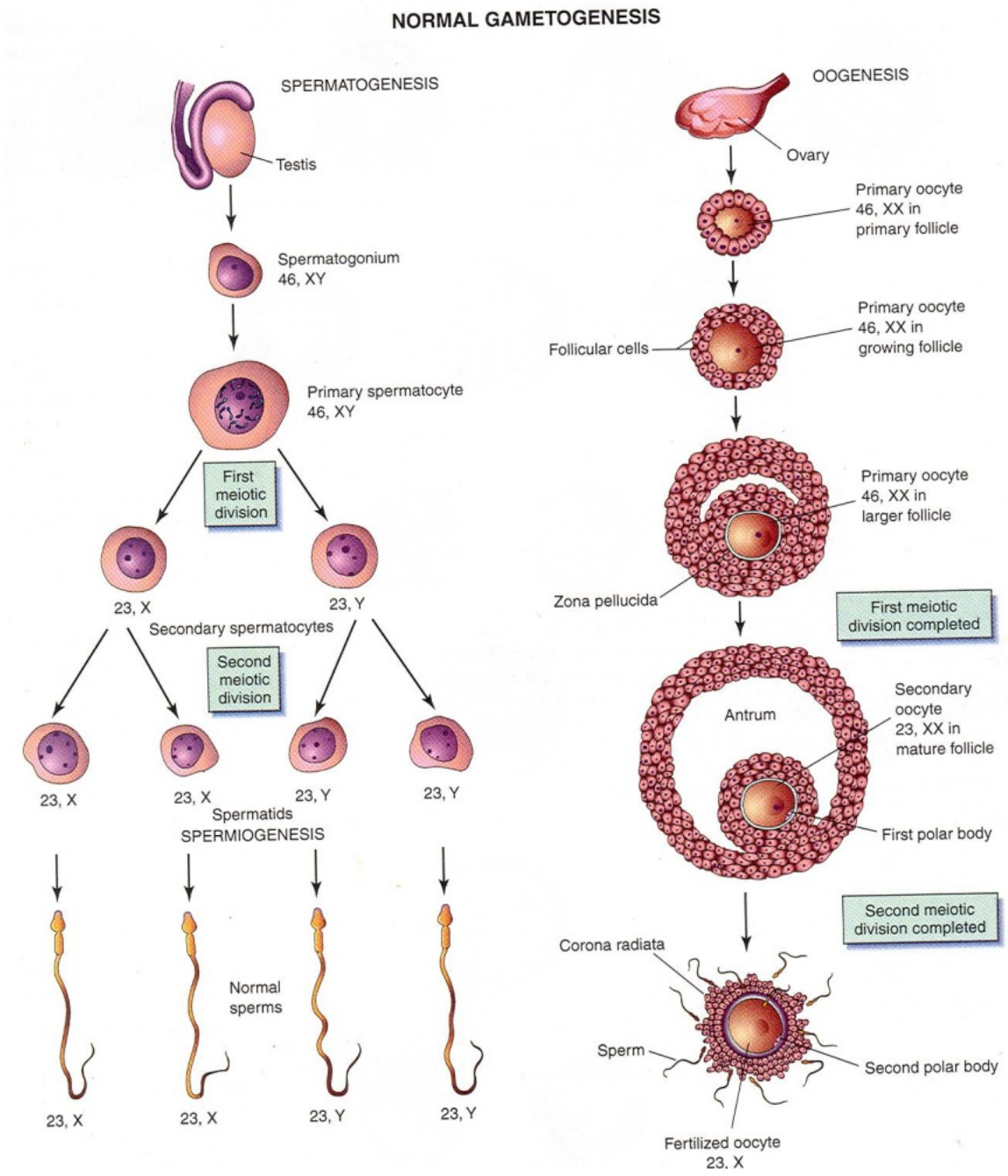
FIRST MEIOTIC DIVISION

Is a reduction division; the chromosome number is reduced from diploid to haploid by pairing of homologous chromosomes



By the end of the first meiotic division, each new cell formed **(Secondary Spermatocyte or Secondary Oocyte)** has haploid (half) number of chromosome.

It is half number of chromosomes of the Primary Spermatocyte or Oocyte.



IMPORTANCE OF MEIOSIS

1. **Provides constancy of chromosome number between generations with reduction of** the number of chromosome from Diploid to Haploid, and production of haploid gametes.
2. Allow random assortment of maternal & paternal chromosomes between the gametes.
3. Relocate segments from maternal & paternal chromosomes by crossing over of chromosomes that produces a recombination of genetic material

SPERMATOGENESIS

AIM:

Formation of sperms with haploid number of chromosomes.

SITE:

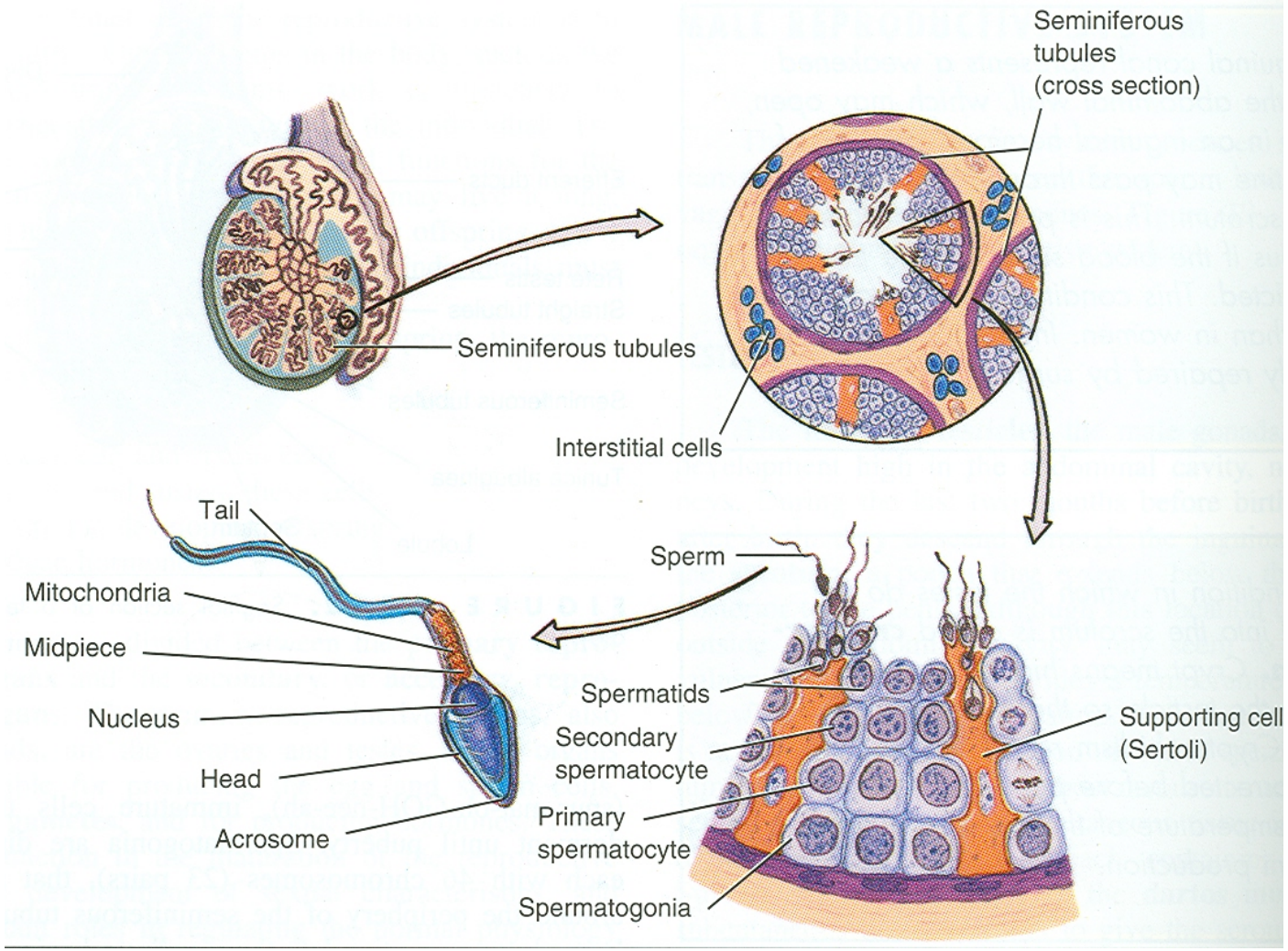
Seminiferous tubules of the testis.

TIME:

From puberty till old age.

DURATION:

About two months



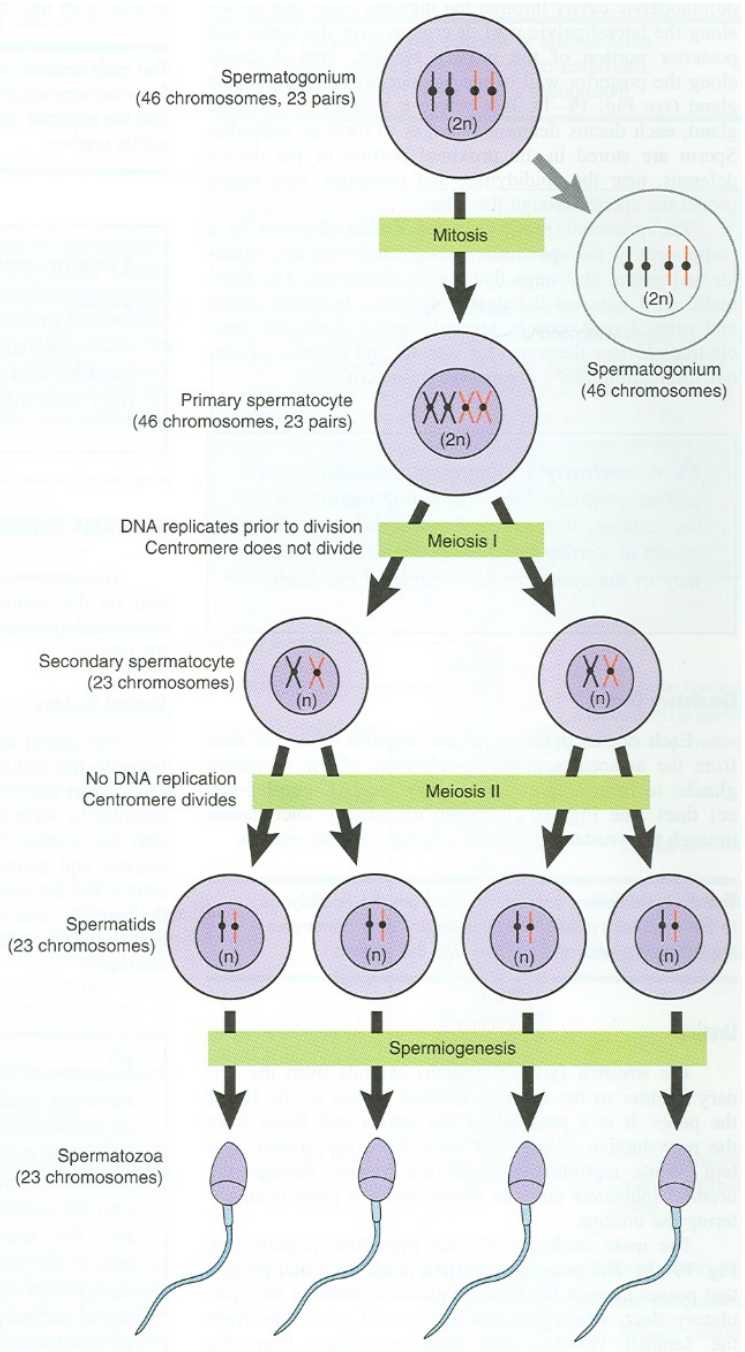
SPERMATOGENESIS

Each spermatogonium divide by mitosis into two daughter spermatogonia (46).

Each daughter spermatogonia grows to give rise to **primary spermatocyte (46).**

Primary spermatocyte undergoes ***meiosis*** to give rise to **secondary spermatocyte (22+ x) or (22+y).**

Each **secondary** spermatocyte divides mitotically to give **spermatid (23).**



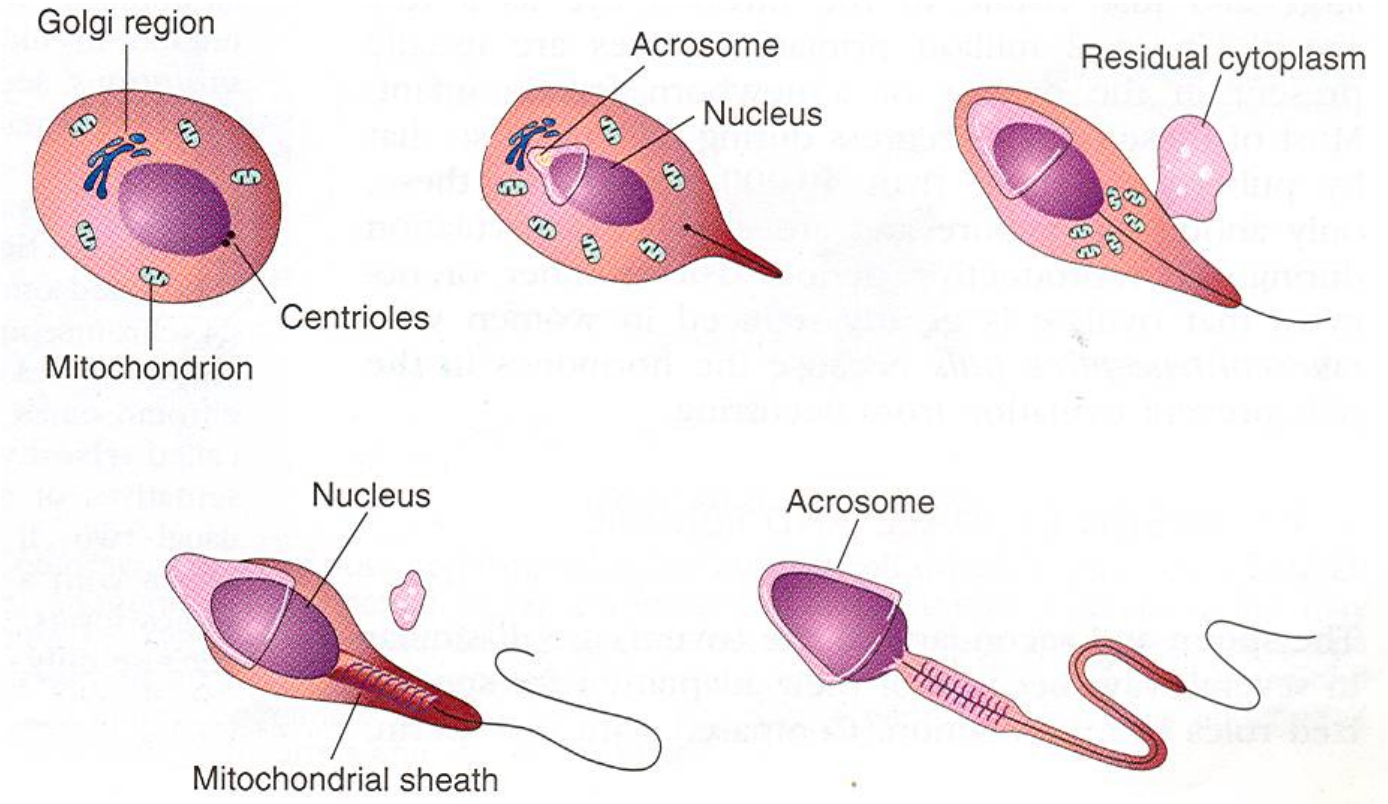
SPERMIOGENESIS

- The spermatids gradually transformed into four sperms by a process spermatogenesis
- It takes about two months
- When the spermiogenesis is completed the sperms enter the lumen of the seminiferous tubules
- They are transformed passively from the seminiferous tubules to the epididymis where they are stored and become functionally mature

SPERMIOGENESIS

It is change in shape (metamorphosis) through which the Spermatids are transformed into mature motile sperms:

1. **Nucleus** is condensed and forms most of the head.
2. **Golgi apparatus** forms the Acrosome.
3. **Mitochondria** forms a spiral sheath.
4. **Centriole** elongates to form the axial filament.



OOGENESIS

AIM:

Formation of secondary oocytes with haploid number of chromosomes.

SITE:

Cortex of the ovary

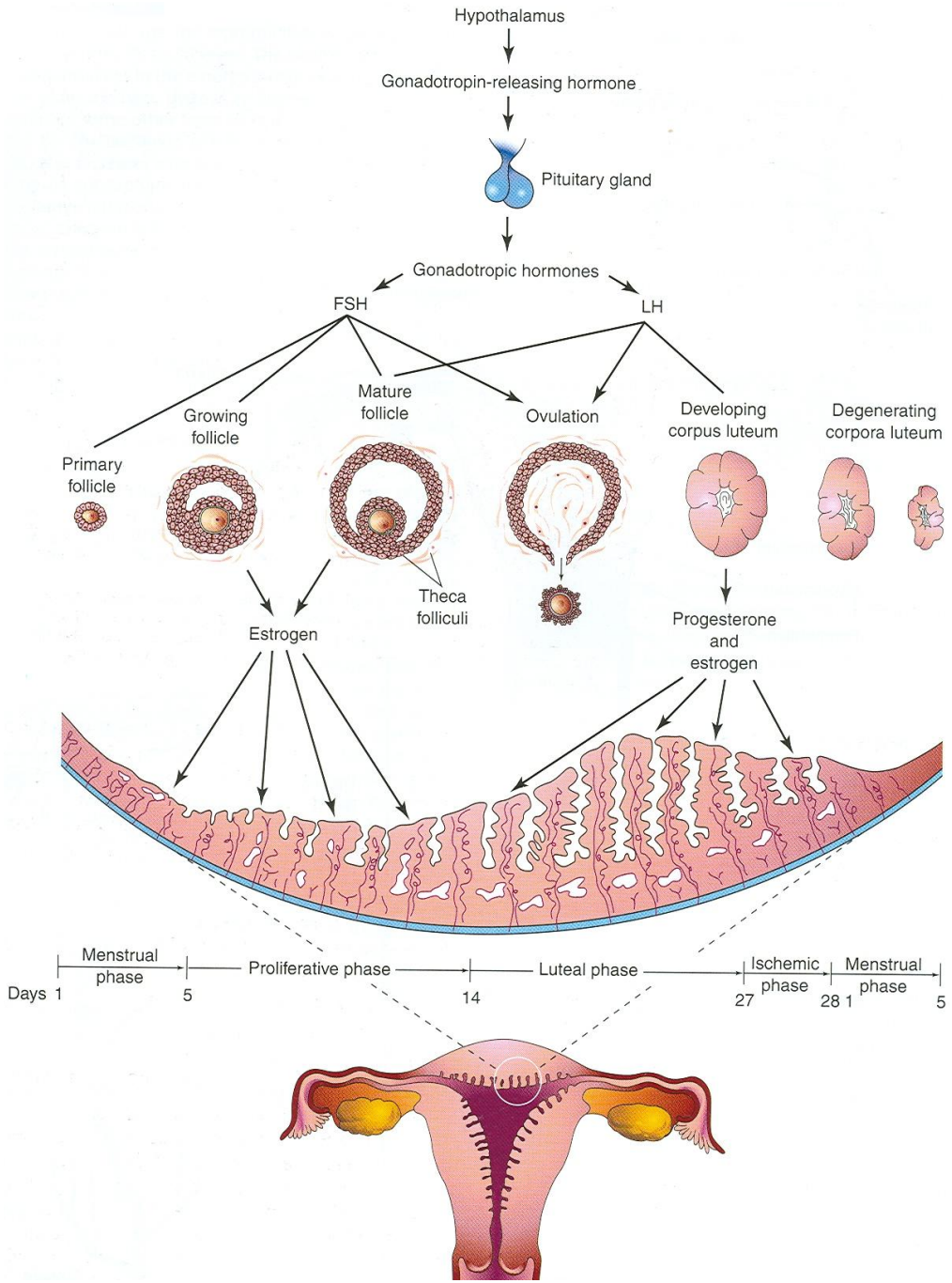
TIME:

Starts during fetal life

Completed after puberty and

Continues until menopause.

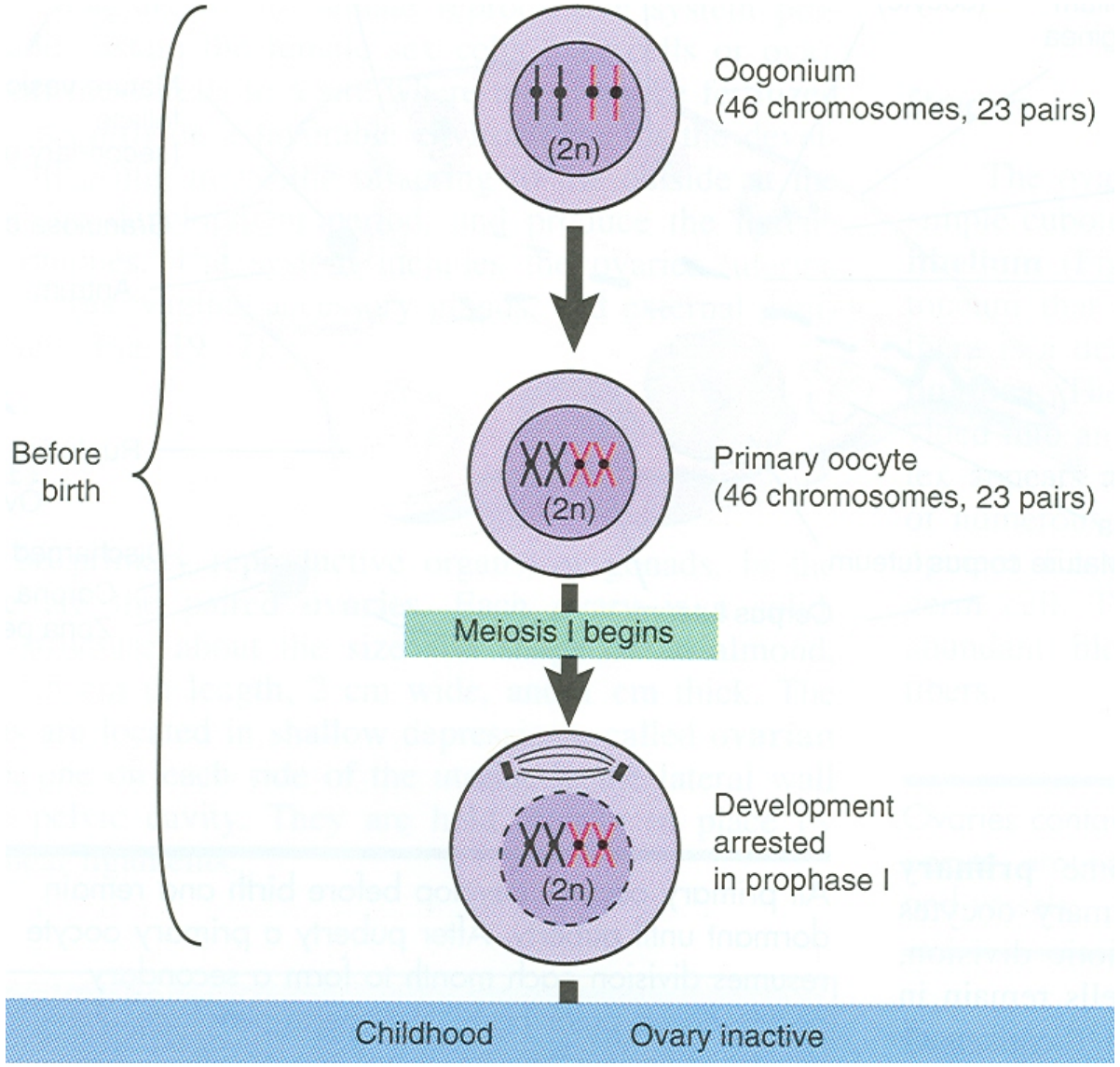
It occurs monthly Except *during pregnancy and after menopause*.



OOGENESIS

During early fetal life, primitive oogonium (46) proliferate by mitotic division and enlarge to form **Primary Oocytes before birth (46).**

Before birth all primary oocytes have began the prophase of the 1st meiotic division and remain **arrested in prophase** and do not finish their first meiotic division until puberty.



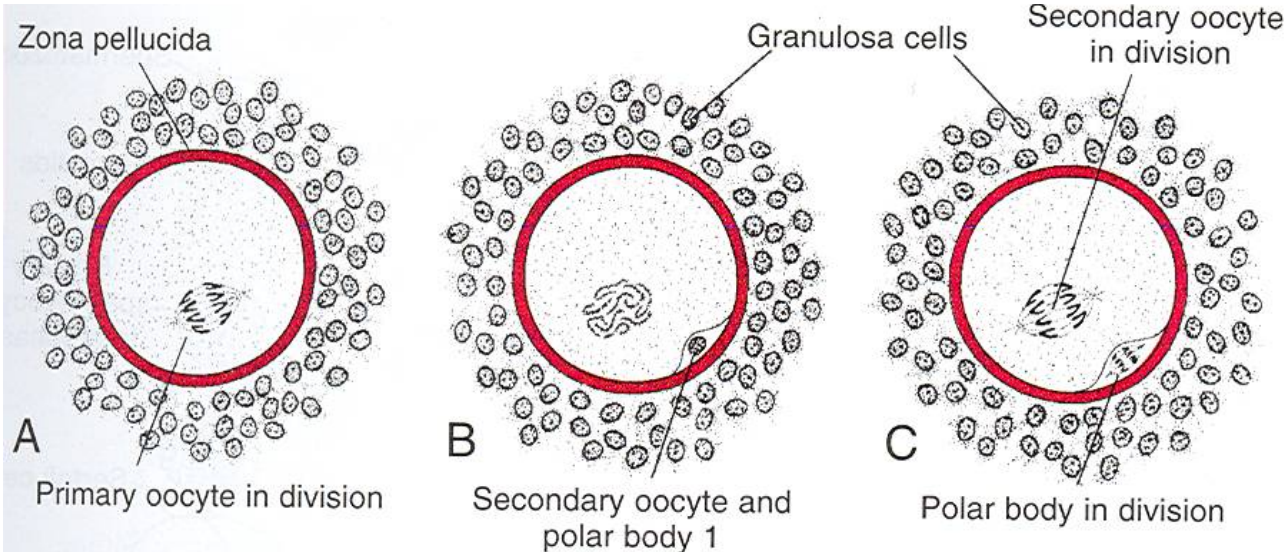
OOGENESIS

After puberty

Shortly before ovulation, the Primary Oocyte completes its first meiotic division to give **secondary oocyte** (23 (22+x))& **First Polar Body.**

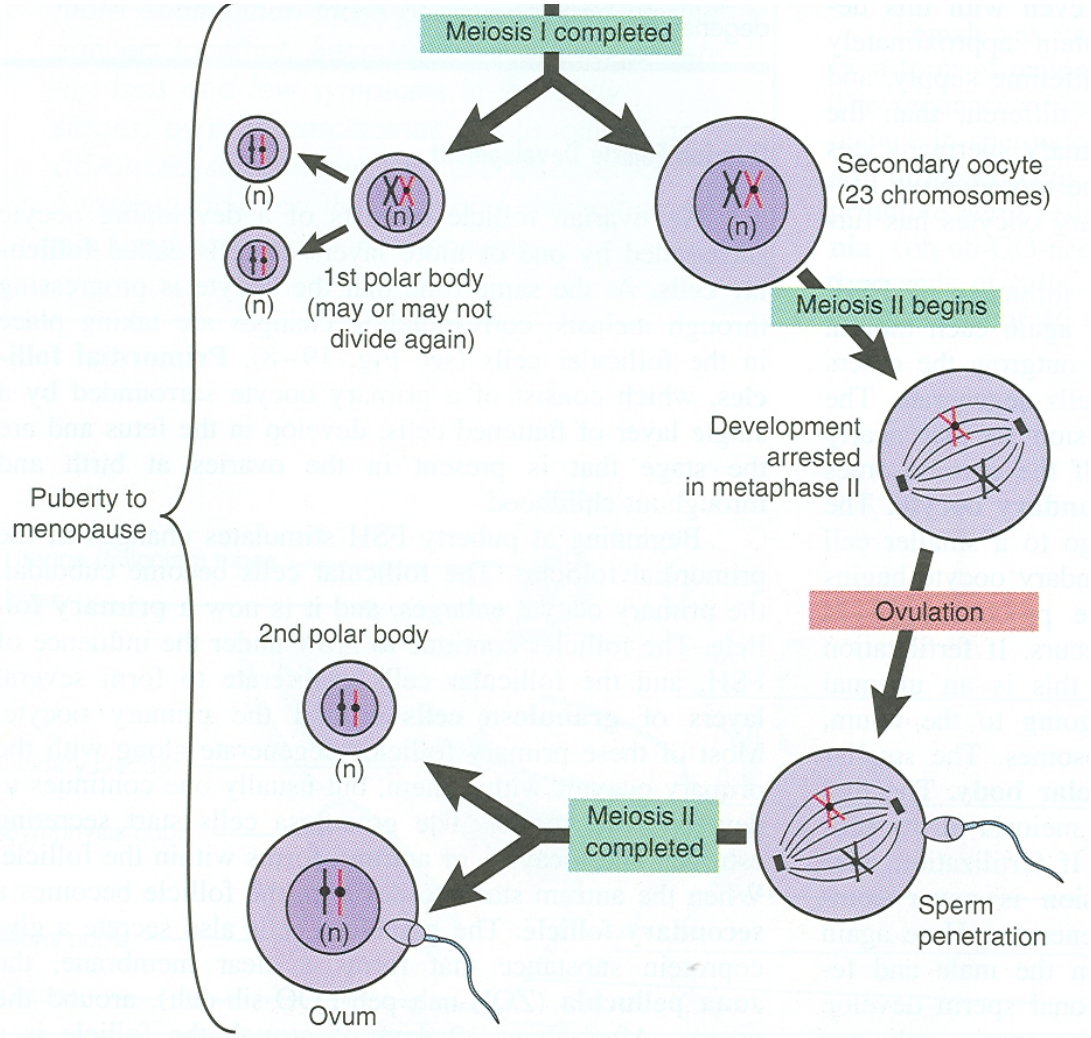
The **Secondary Oocyte** receives almost all the cytoplasm.

The First Polar Body receives little cytoplasm, it is a small nonfunctional cell that soon degenerates.



OOGENESIS

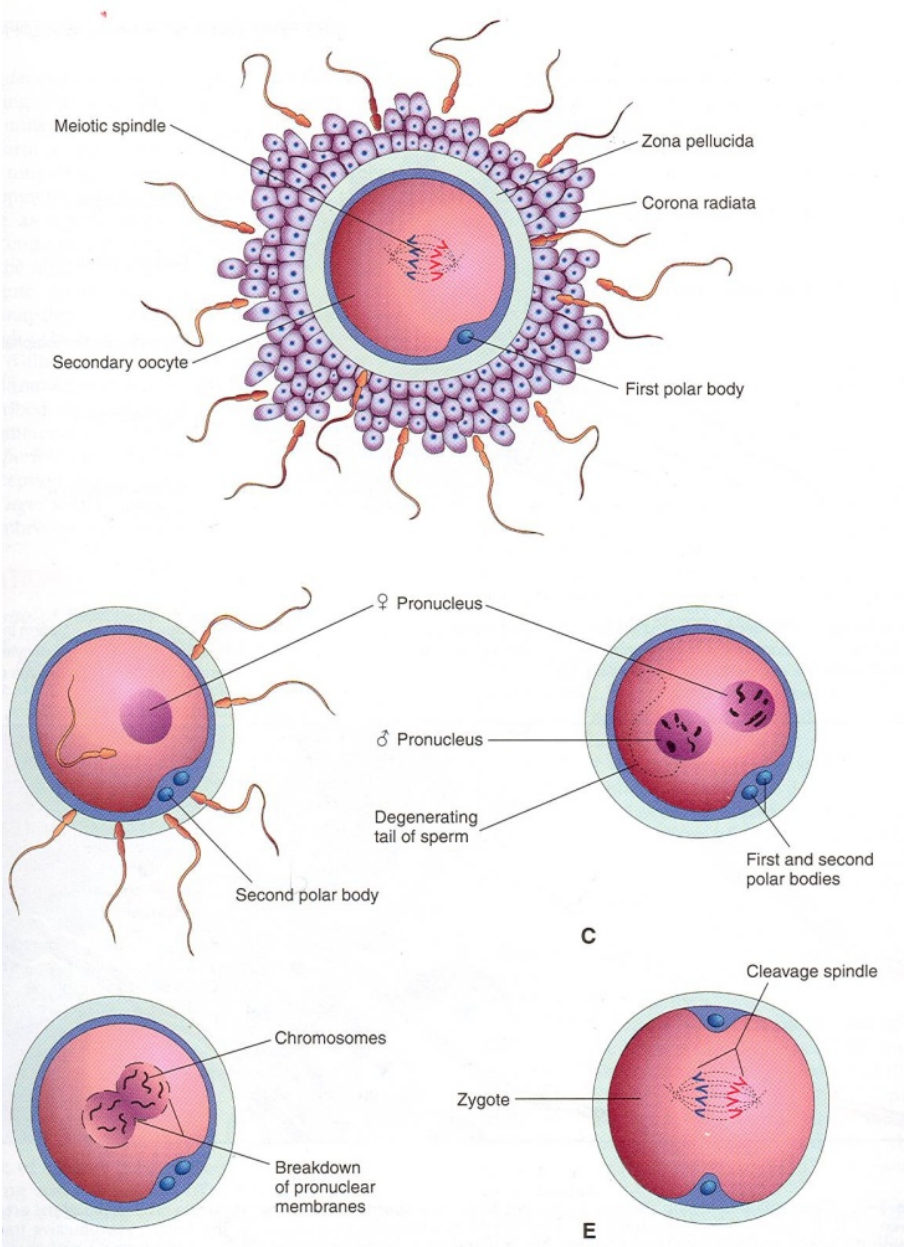
At ovulation, the nucleus of the secondary oocyte begins the second meiotic division but progresses only to ***metaphase*** *where division is arrested.*



If the secondary oocyte is fertilized, the second meiotic division is completed otherwise it degenerates 24 hours after ovulation.

Most of the cytoplasm go to the Mature Oocyte (Fertilized Oocyte).

The rest is in the 2nd Polar Body which soon degenerates.



DURING FETAL LIFE	AFTER PUBERTY DURING EACH OVARIAN CYCLE	AFTER FERTILIZATION
Proliferation: each oogonium divides by mitosis into 2 daughter oogonia (with diploid number of chromosomes: (44 + XX) **Growth:** oogonium enlarges to form primary oocyte (with diploid number). Primary oocytes begin 1st meiotic division which stops at **prophase**	**1st meiotic division is completed**: (shortly before ovulation): a reduction division by which a primary oocyte divides into one secondary oocyte (haploid number of chromosomes: (22 + X) & 1st polar body (degenerates) **2nd meiotic division begins:** begins at ovulation, progresses only to **metaphase** and becomes arrested.	**2nd meiotic division is completed:** 2ry oocyte divides into a mature ovum (haploid number) & 2nd polar body (degenerates).

N.B.: NO PRIMARY OOCYTES FORM AFTER BIRTH

Errors in Meiosis

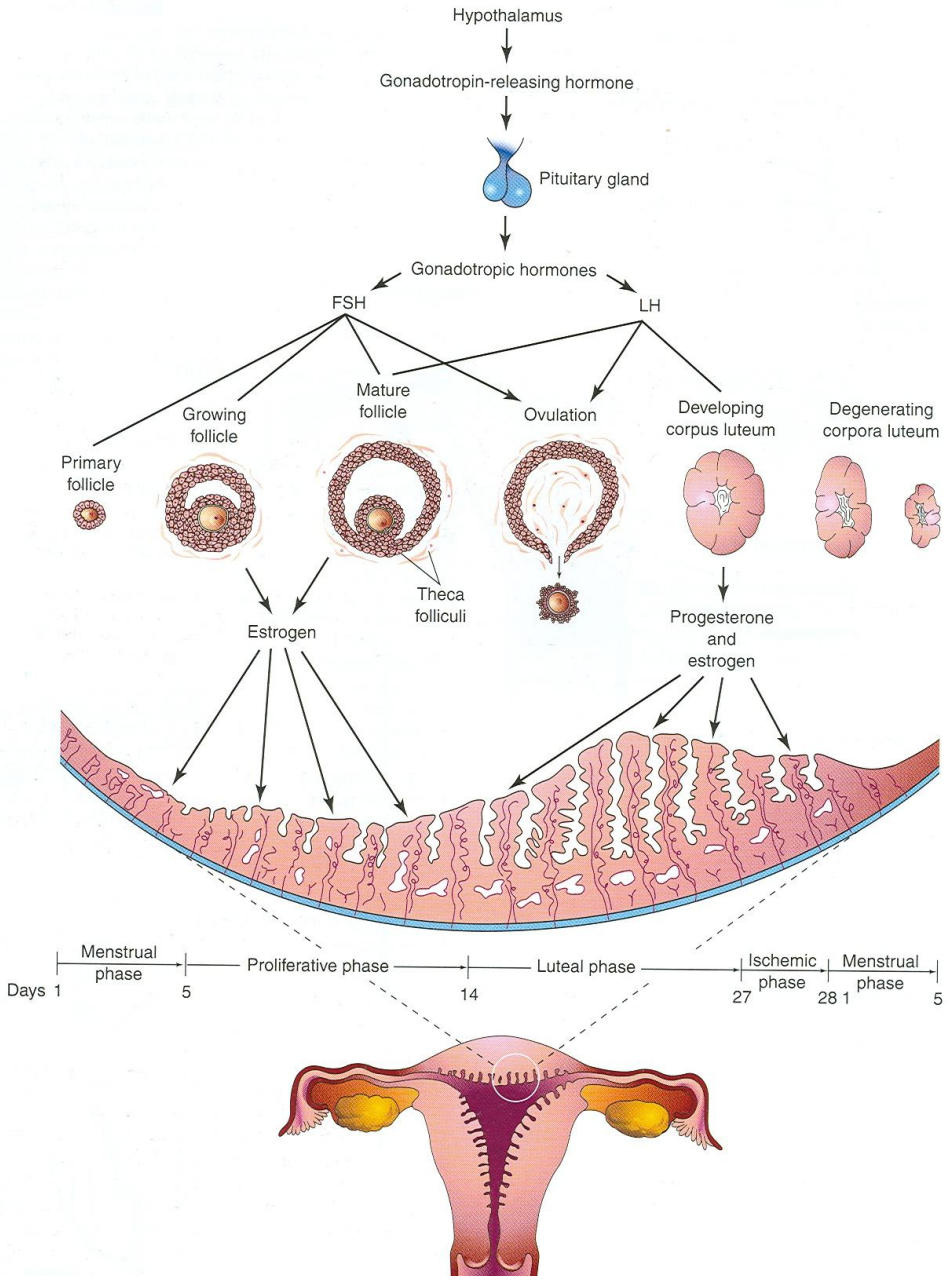
- Errors in gametogenesis can lead to a number of chromosomal abnormalities including non-disjunction or polyploidies.
- Non-disjunction occurs when chromosomes fail to separate appropriately.
- Polyploidy occurs when there are more than 2 copies of a homologous chromosome in a cell.

- Errors in gametogenesis can lead to:
- Trisomy
  - Down's Syndrome – trisomy 21
  - Edward's Syndrome – trisomy 18
- Monosomy as Turner syndrome
- Obstetricians can aid parents to screen for chromosomal abnormalities antenatally.

Female Reproductive Cycles

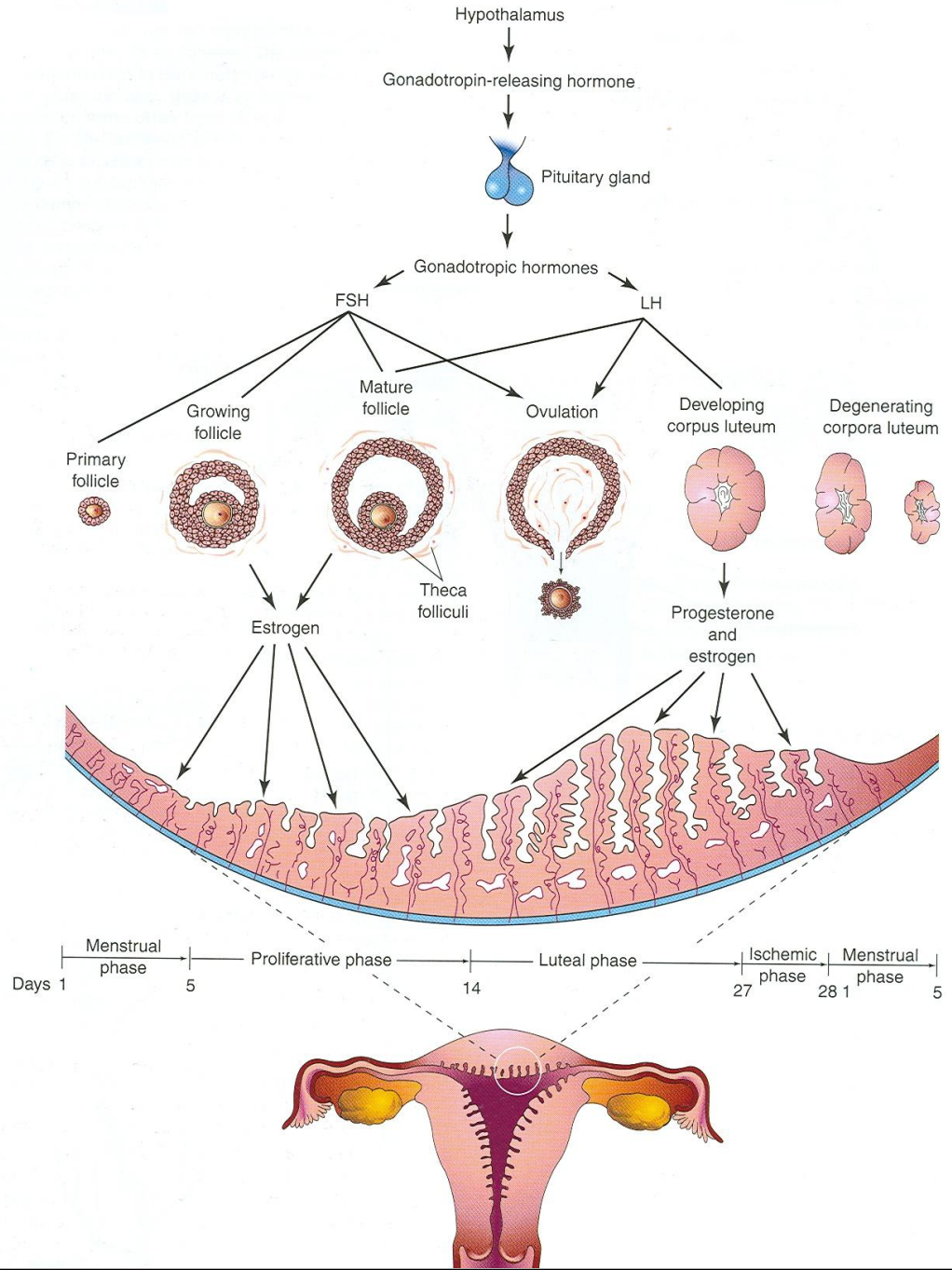
OVARIAN AND UTERINE CYCLES

- Start at puberty.
- Normally continues until the menopause.
- <u>Reproductive cycles depend upon activities of:</u>
- Hypothalamus,
- Pituitary gland,
- Ovaries,
- Uterus,
- Uterine tubes,
- Vagina and
- Mammary glands



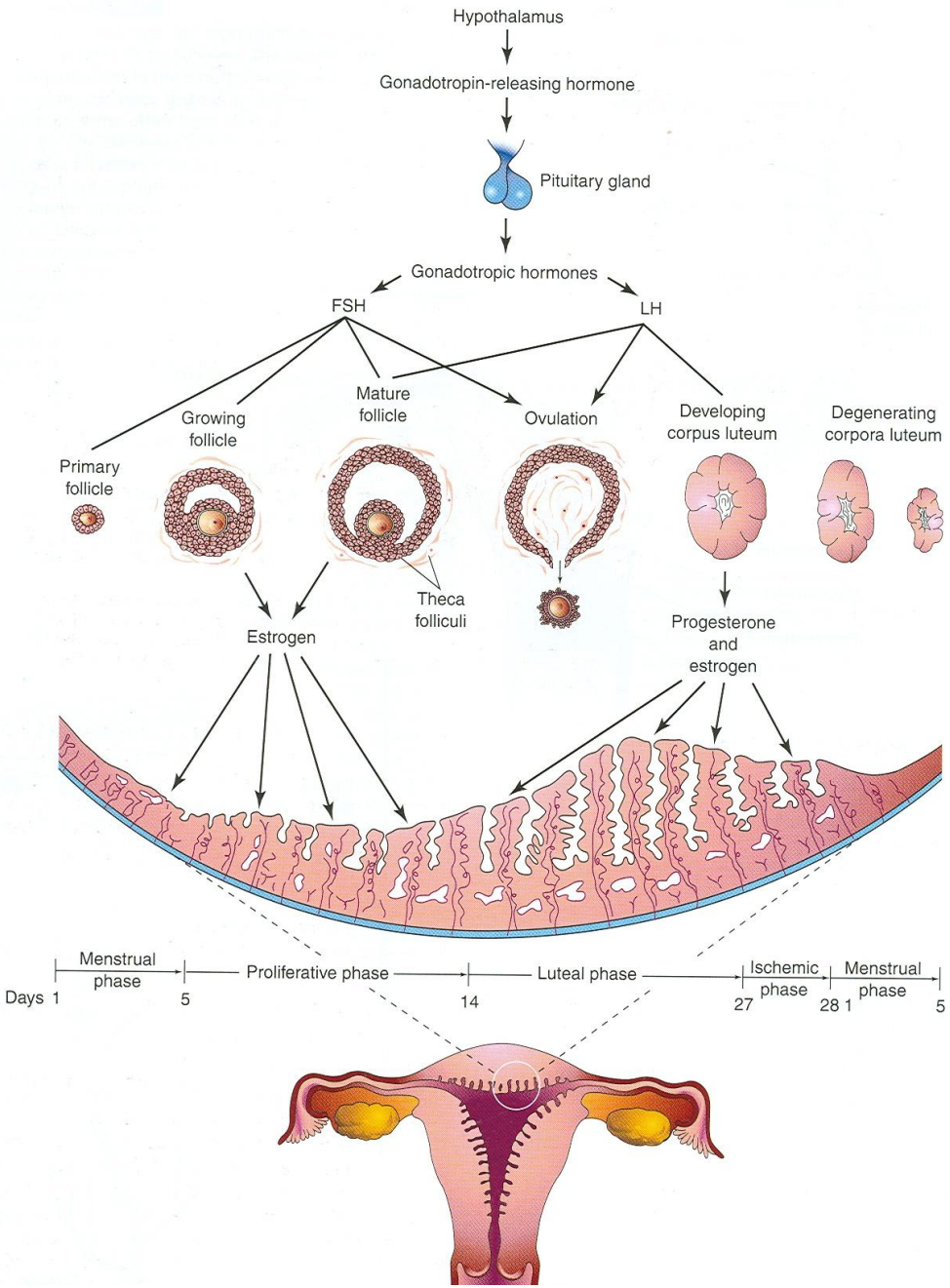
Gonadotrophin

- Gonadotrophin-releasing hormone (GnRH) is synthesized by neurosecretory cells in the Hypothalamus.
- Carried to the Pituitary gland (anterior lobe).
- It stimulates the pituitary to release Two *Hormones* that act on Ovaries.



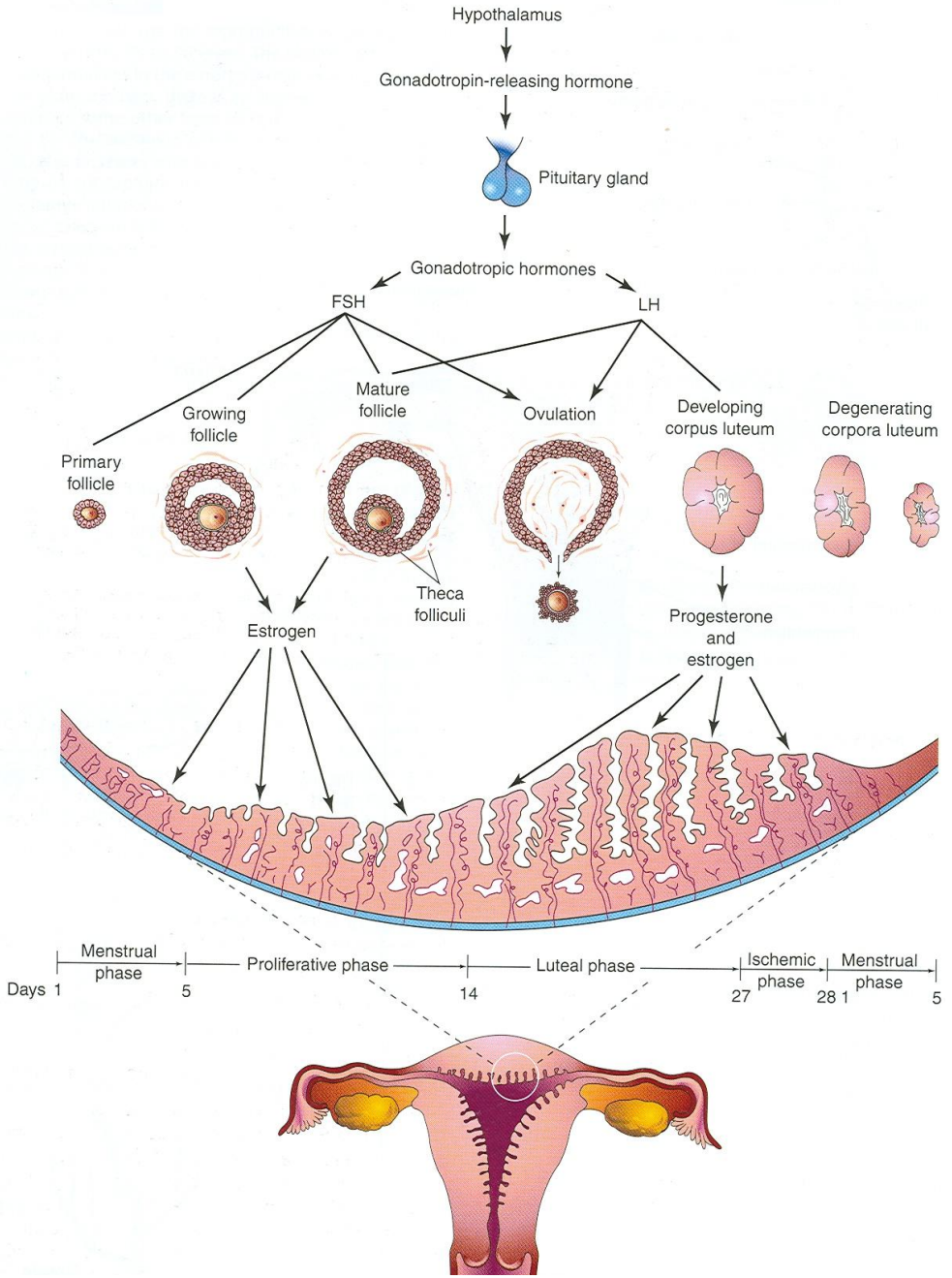
Follicle-Stimulating Hormone .

- **FUNCTIONS:**
- 1- It stimulates the ovarian follicles to develop.
- 2- Production of *Estrogen* by the follicular cells.



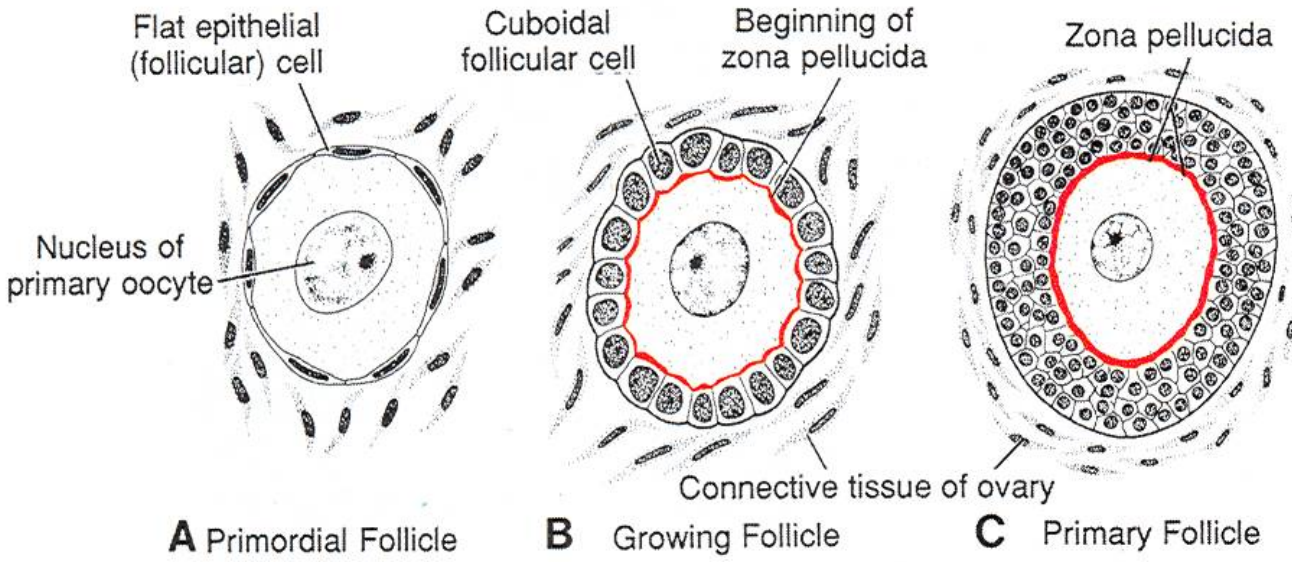
Luteinizing Hormone.

- **FUNCTIONS:**
- 1- It serves as the trigger for ovulation.
- 2- Stimulates the follicular cells and corpus luteum to produce **Progesterone.**



OVARIAN CYCLE

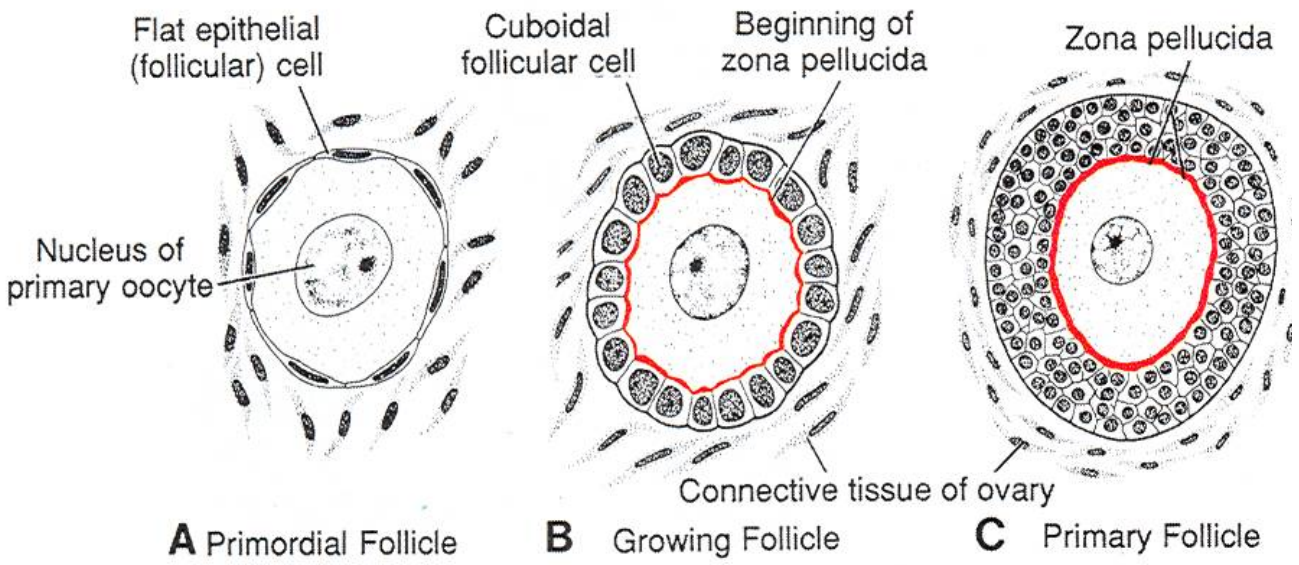
- It is under the control of the Pituitary Gland.
- It s divided into 3 phases:
- **1- Follicular,**
- **2- Ovulation and**
- **3- Luteal.**



The simple flat follicular cells become cuboidal, then columnar then forming many layers around the oocyte, (granulosa cells).

OVARIAN CYCLE

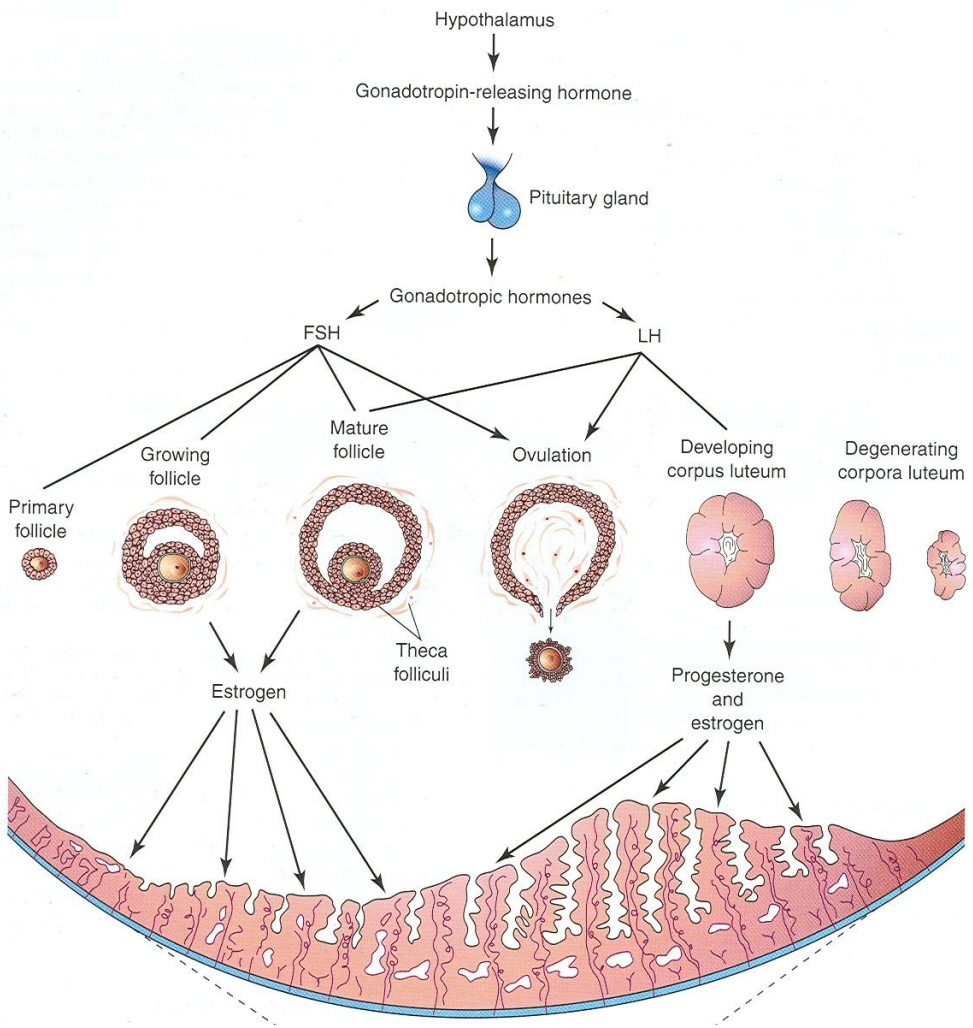
- The ovarian cortex contains hundreds of thousands of primary follicles.
- Each consists of one primary oocyte encircled by single layer of flat cells.
- **F.S.H.** stimulates a number of 1ry follicles to develop into mature graafian follicle.



The simple flat follicular cells become cuboidal, then columnar then forming many layers around the oocyte, (granulosa cells).

Follicular phase

- The follicle becomes enlarge until it gets complete maturity.
- It produces swelling on the surface of the ovary.
- Early development of ovarian follicle is induced by FSH.
- Final stages of maturation require LH.



Growing follicles produce estrogen which regulates the development and functions of the reproductive organs.

Ovulation Phase

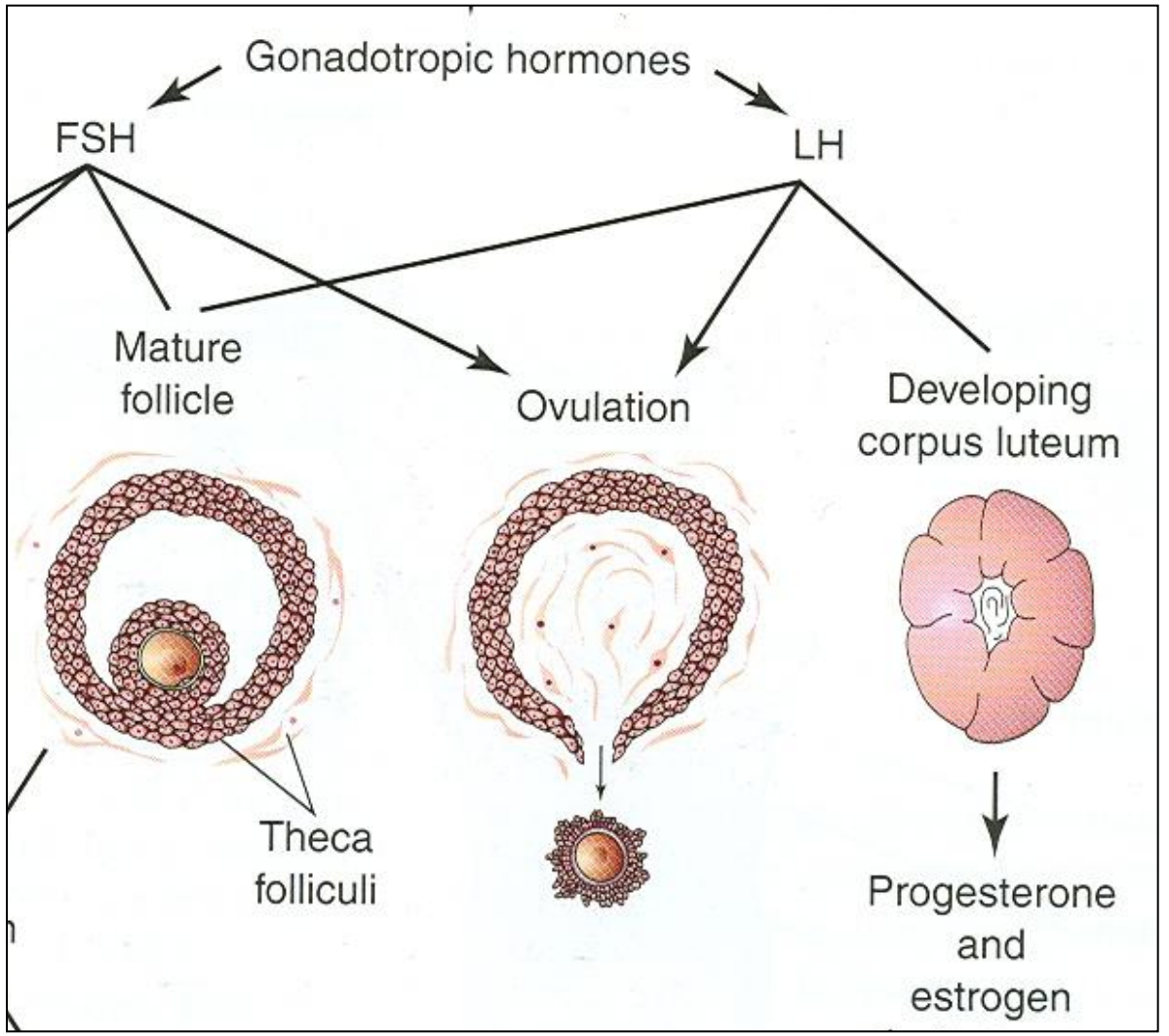
It is triggered by LH.

Only one follicle usually reaches full maturity and becomes the mature graafian follicle.

The follicle increases in size due to collection of fluid until it ruptures .

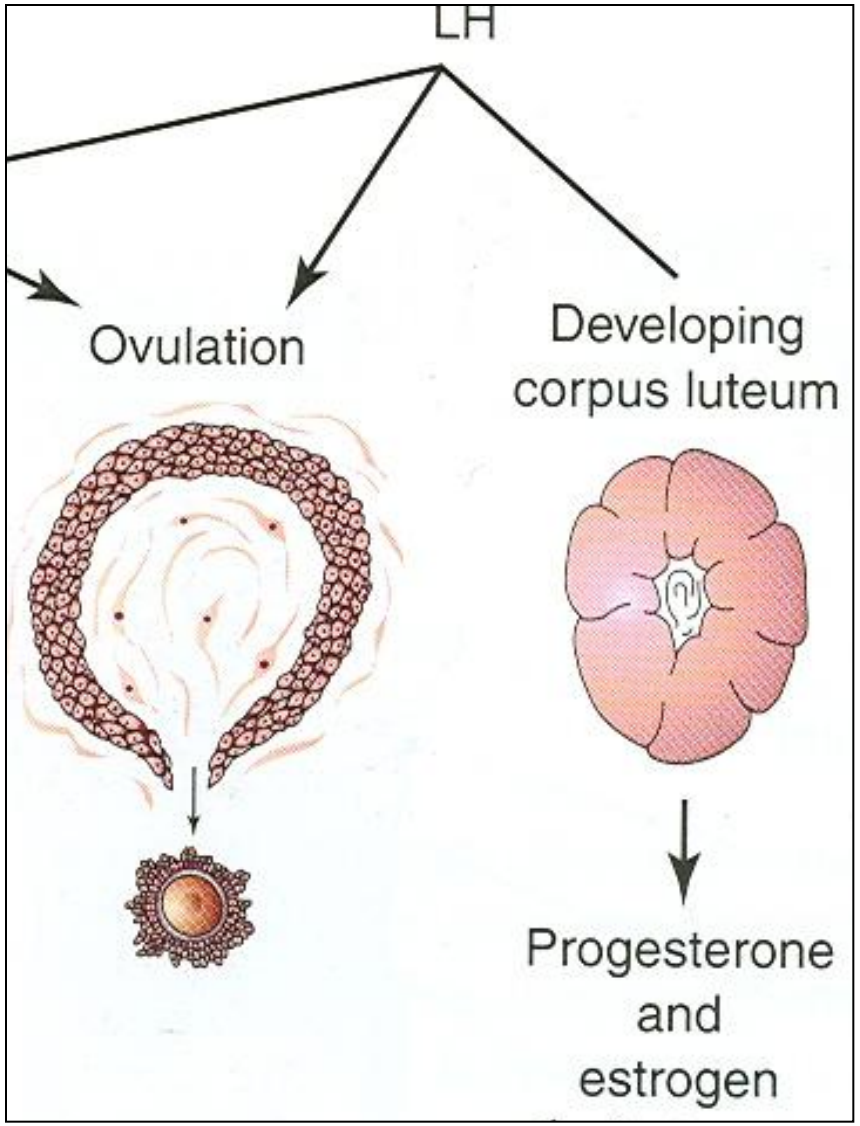
The other follicles degenerate.

The remaining of the ruptured follicle is called corpus luteum.



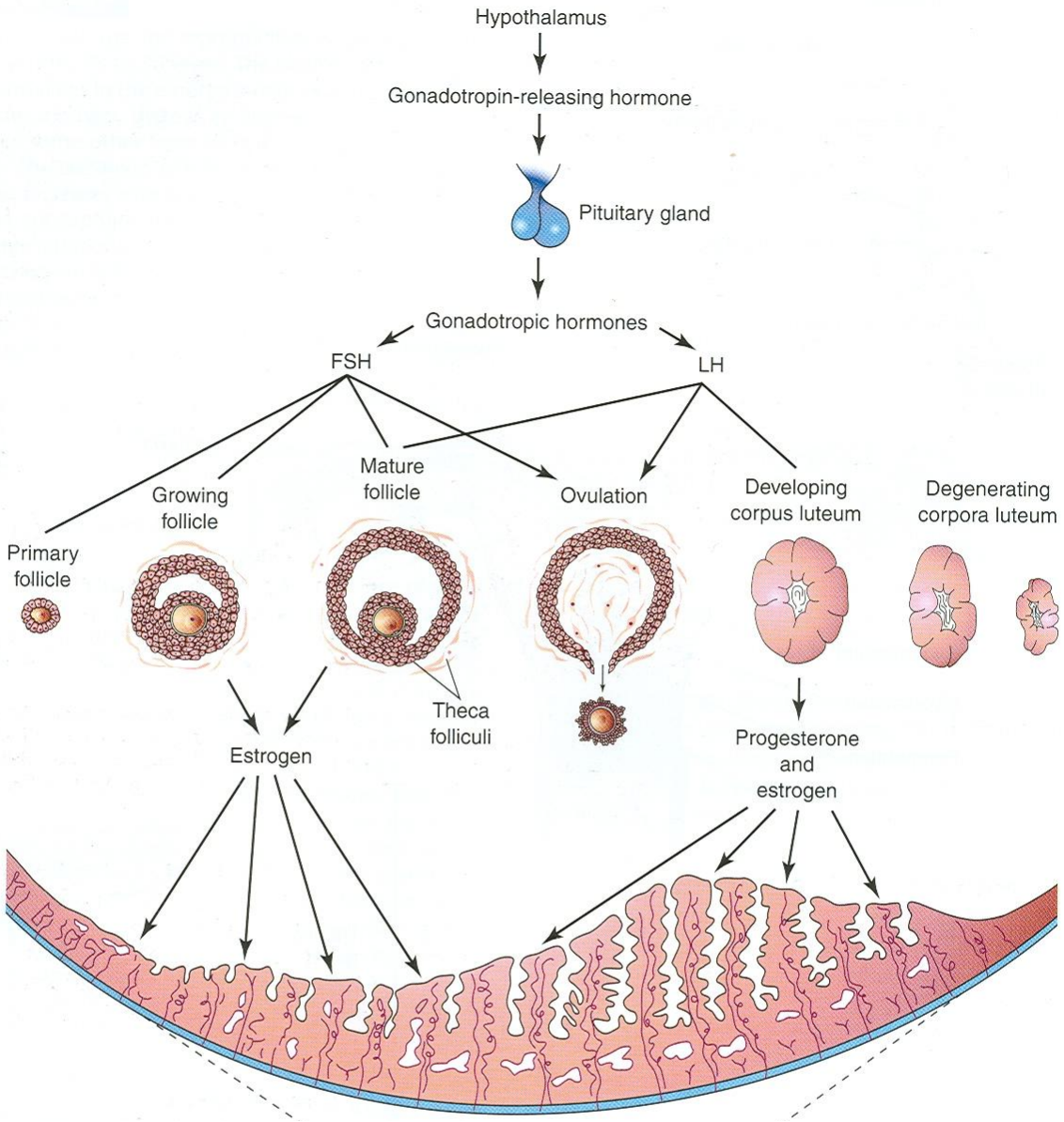
Luteal Phase

By the 14th day of menstrual cycle the (LH) of the pituitary gland stimulates the rupture of the mature follicle which changes into corpus luteum.



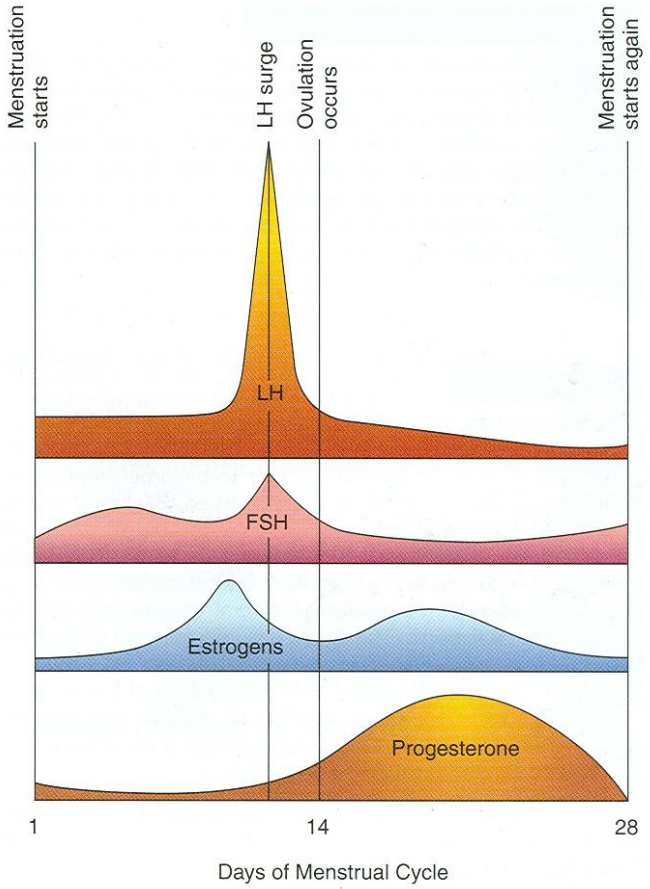
Corpus Luteum

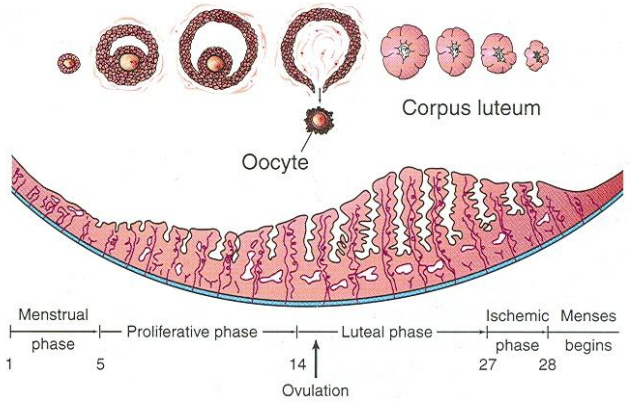
- It secretes **Progesterone** and some **Estrogen.**
- These 2 hormones stimulate endometrial glands to secrete and prepare endometrium for implantation of the fertilized Ovum (Blastocyst).
- If the oocyte is fertilized the Corpus Luteum enlarges and remains till the 4th month of pregnancy.
- If the oocyte is not fertilized the corpus luteum involutes and degenerates in 10-12 days.



Uterine or Menstrual Cycle

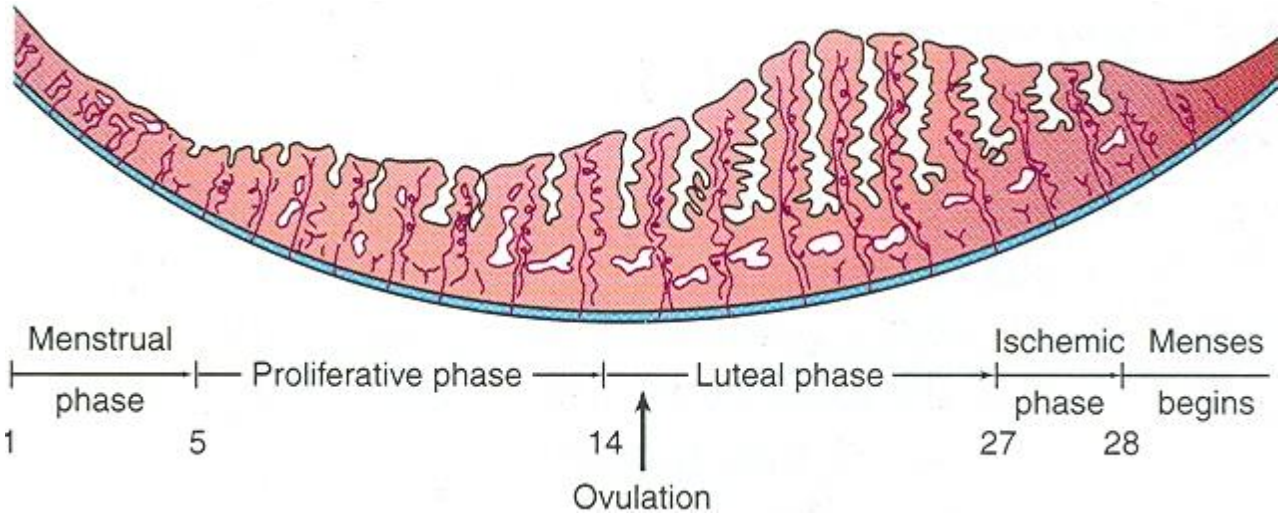
- Cyclic changes in the endometrium of the uterus caused by estrogen & progesterone.
- Average menstrual cycle is 28 days.
- Day 1 is the day when menstrual flow begins.
- It varies by several days in normal women.
- Ranges between 23 and 35 days in 90% of women.





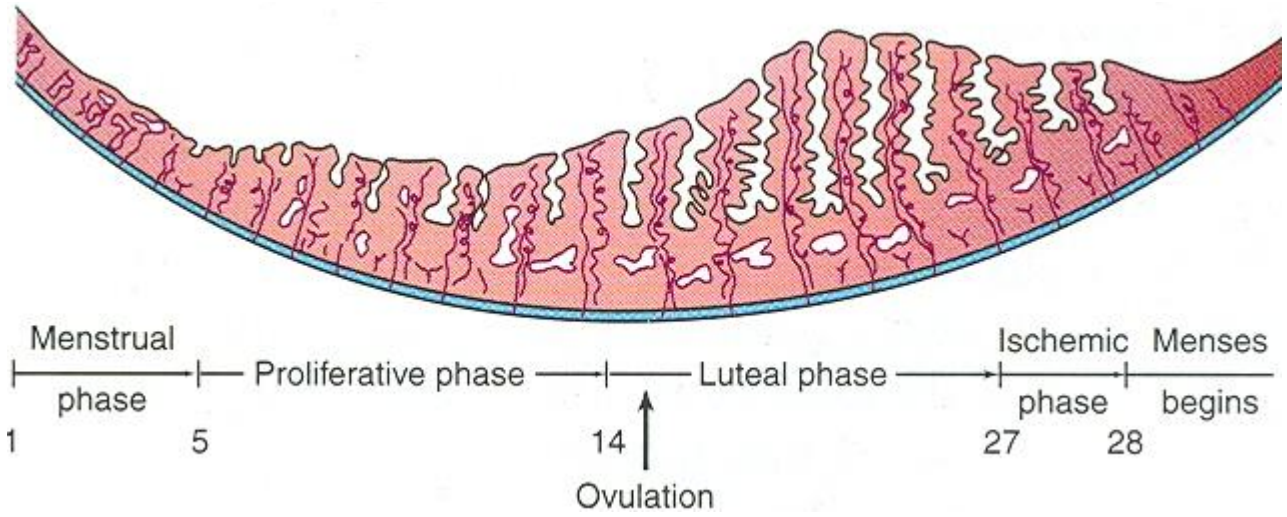
Phases of Menstrual Cycle

- Menstrual Phase.
- Proliferative or Follicular Phase.
- Luteal Phase.
- Ischemic Phase.



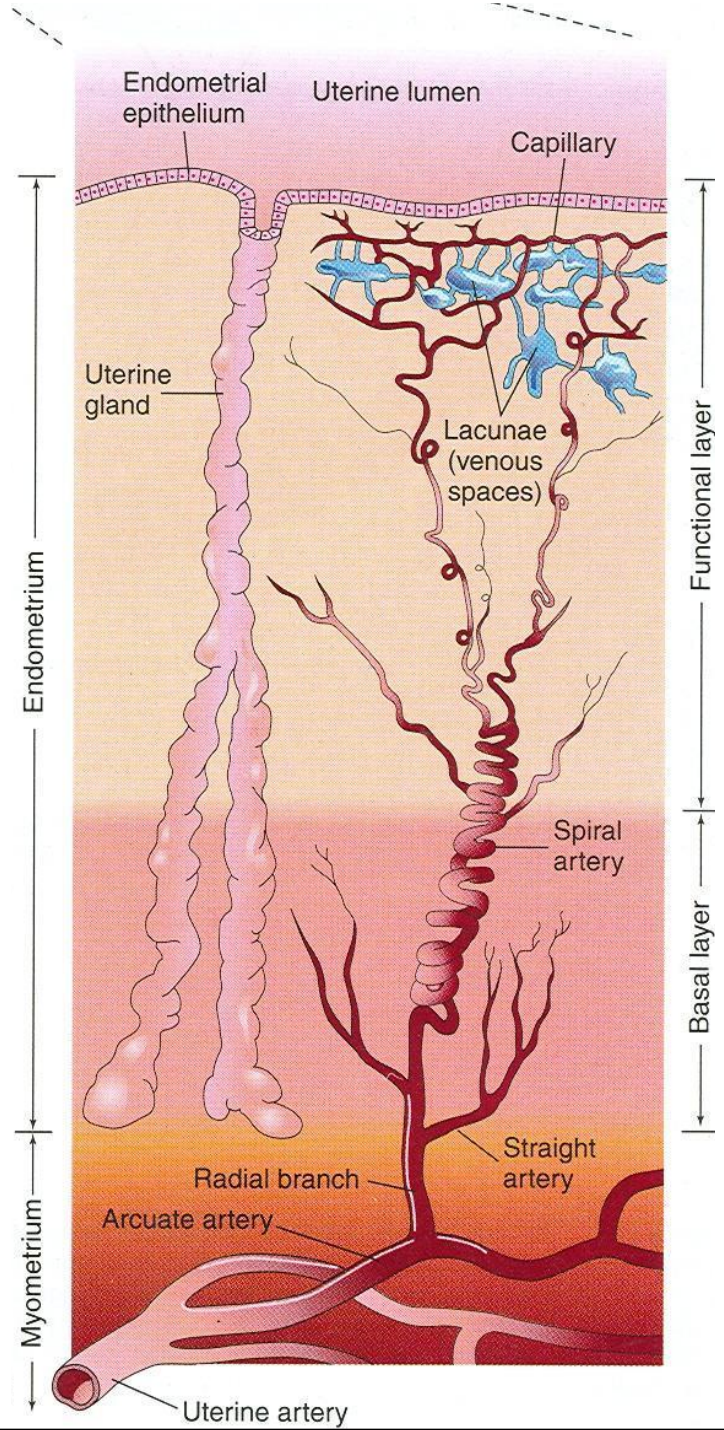
Menstrual Phase

- Starts with 1st day of menstrual cycle.
- Lasts for 4-5 days.
- Functional layer of the endometrium is sloughed off and discarded with the menstrual flow.
- Blood discharge from vagina is combined with small pieces of endometrial tissue.



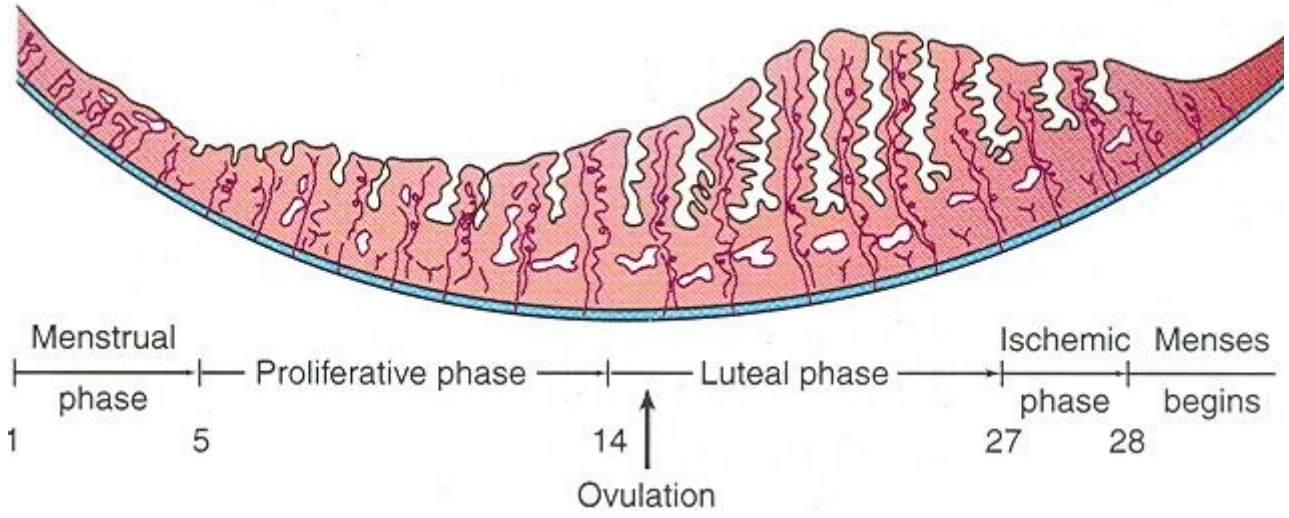
Proliferative Phase

- Is a phase of repair and proliferation.
- Lasts for 9 days.
- Coincides with growth of ovarian follicle.
- Controlled by Estrogen secreted by the follicular cells.
- Thickness of the endometrium is increased into 2-3 folds.
- The glands increase in number and length and the spiral arteries elongate.



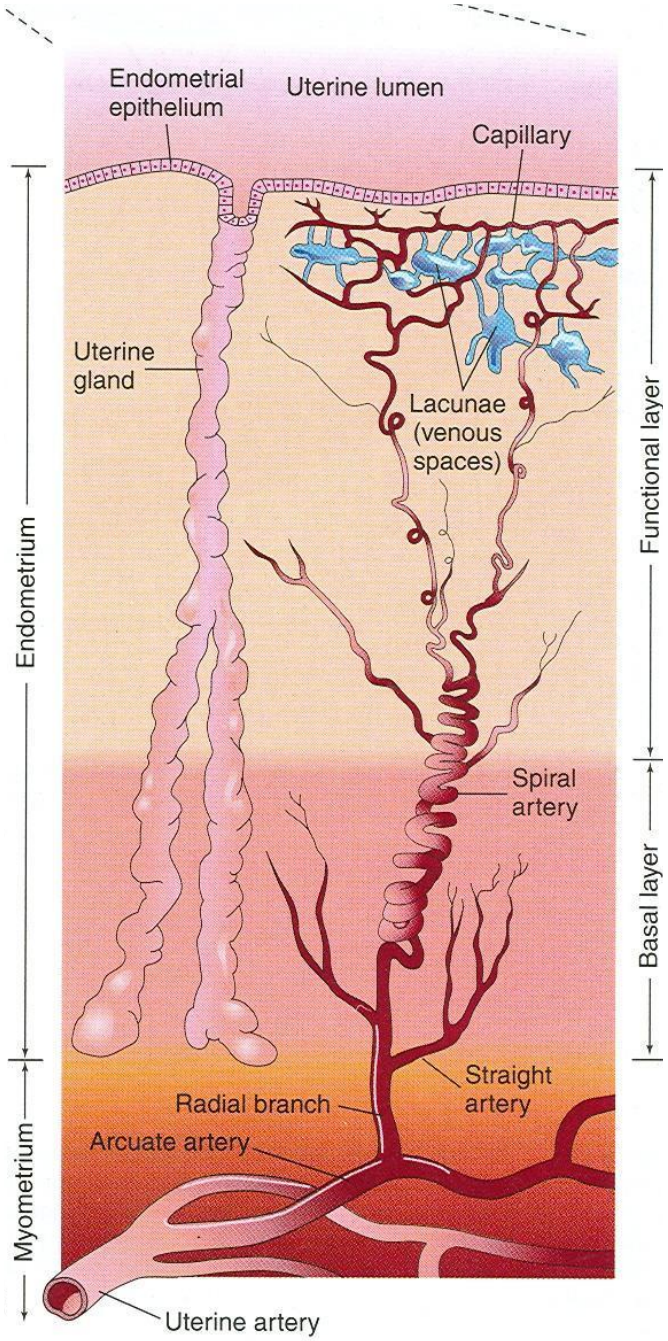
Luteal Phase

- Is a Secretory or Progesterone phase.
- Lasts about 13 days.
- Coincides with formation, growth and functioning of the Corpus Luteum.
- Glandular epithelium secrete glycogen rich material.
- Endometrium thickens under the influence of estrogen and progesterone.



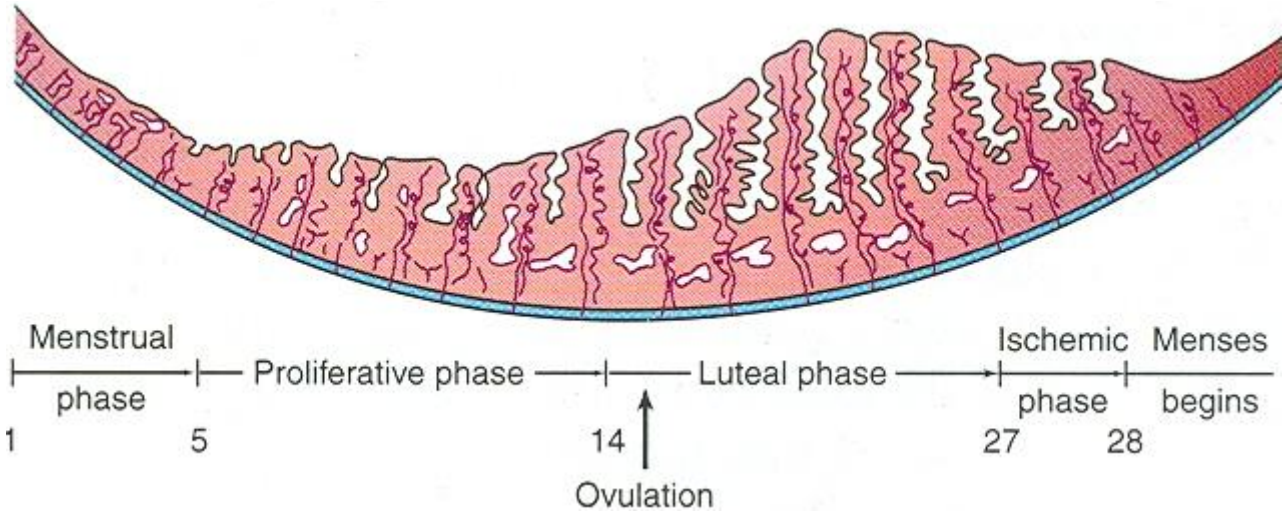
Luteal Phase

- Spiral arteries grow into the superficial layer.
- Arteries become increasingly coiled.
- Large venous network develops.
- Direct arterio-venous anastomosis are the prominent features.



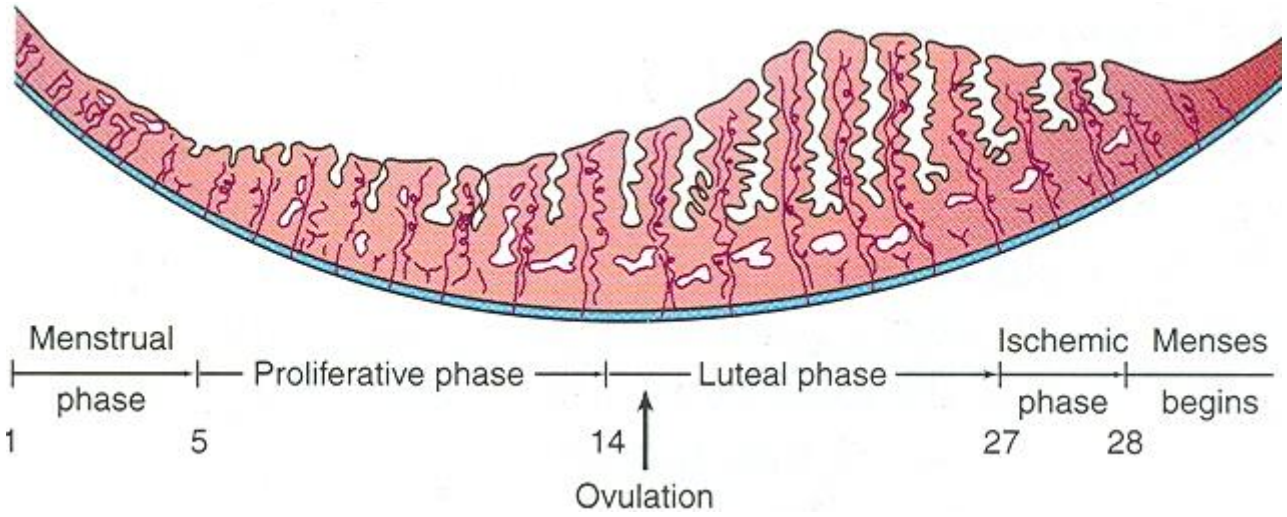
Ischemic Phase

- Degeneration of corpus luteum decreases levels of progesterone & estrogen.
- Loss of interstitial fluid
- Marked shrinking of endometrium.
- Spiral arteries become constricted.
- Venous stasis & Ischemic necrosis.



Ischemic Phase

- Rupture of damaged vessel wall.
- Blood seeps into the surrounding connective tissues.
- Loss of 60-80 ml of blood
- Entire compact layer and most of the spongy layer of endometrium is discarded



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