

The Fundamentals of Embryology

GAMETOGENESIS & FEMALE CYCLES

أَوَّلًا يَذْكُرُ الْإِنْسَانَ أَنَّمَا خَلَقْتَهُ مِنْ قَبْلُ وَلَمْ
يَكُ شَيْئًا ﴿١٧﴾



Embryology
436



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OBJECTIVES:

By the end of the lecture, you should be able to:

- Describe the female cycles (**Ovarian & Uterine**).
- Define **gametogenesis**.
- Differentiate the types of **gametogenesis**.
- Describe the process of **spermatogenesis**.
- Describe the process of **oogenesis**.

OVARIAN AND UTERINE CYCLES:

It starts at **puberty** and normally continues until **the menopause**.

Reproductive cycles depend upon activities & coordination of:

- Hypothalamus
- Pituitary gland
- Ovaries
- Uterus
- Uterine tubes
- Vagina
- Mammary glands

Hypothalamus

- It has **neurosecretory** cells that synthesize Gonadotrophin-releasing hormone (**GnRH**)

GnRH is carried to



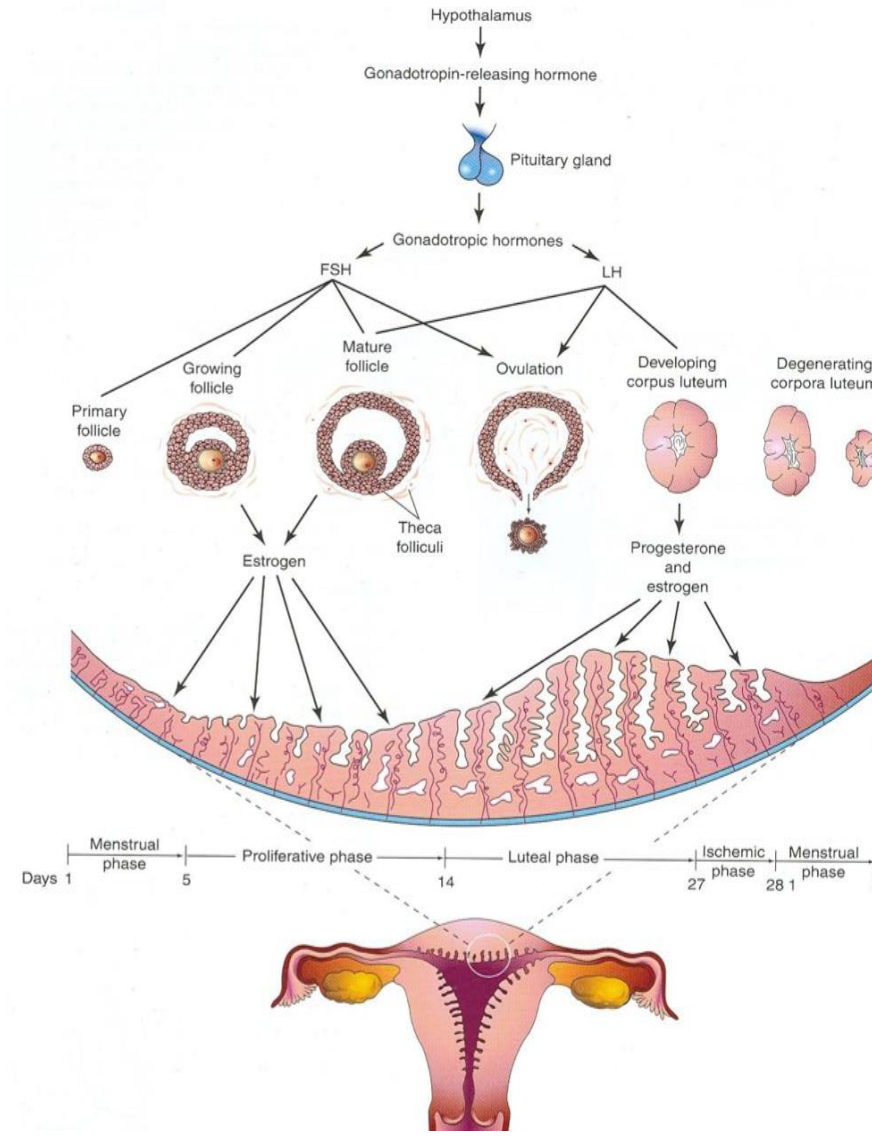
The Pituitary gland (anterior lobe)

- stimulates it to release two Hormones that act on ovaries



LH

FSH

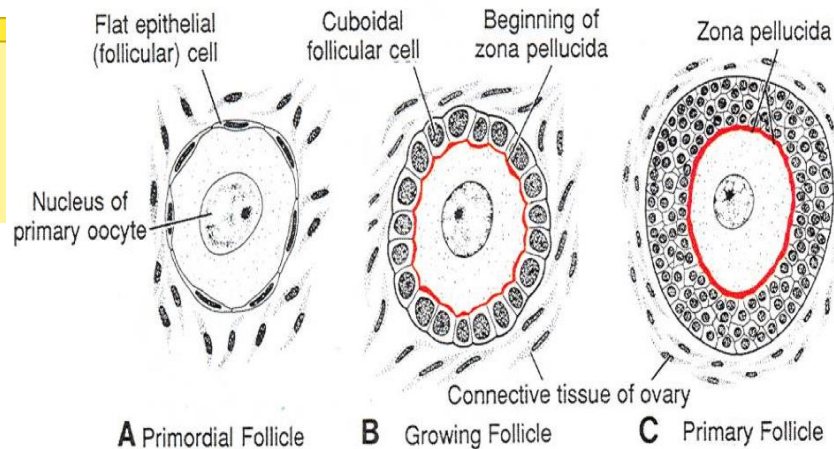
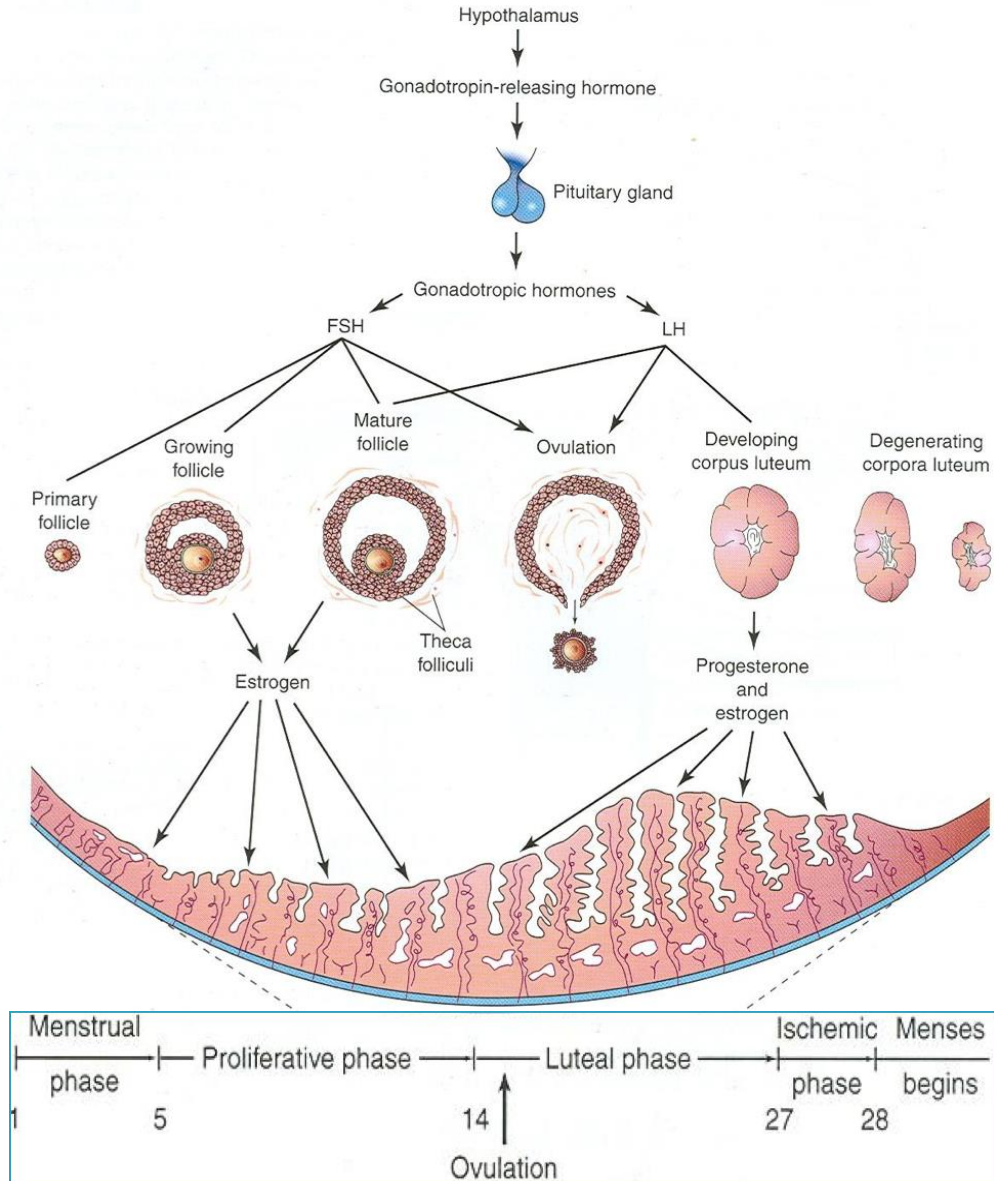


THE OVARIAN CYCLE:

The ovarian cortex contains hundreds of thousands of **primordial follicles** (400,000 to 500,000). Each primordial follicles consists one of **primary oocyte** encircled by single layer of **flat follicular cells**.

The **ovarian cycle** is under the control of the **Pituitary Gland**, and it has three phases: (**FOL**)

- 1- Follicular (**FSH**)
- 2- Ovulatory (**LH**)
- 3- Luteal (**LH**)



Notes:
All the primary oocytes are formed before the birth of the female.
(No primary oocytes are formed after birth)
All primary oocytes have only completed the **prophase**

THE OVARIAN CYCLE:

Follicular Phase

FSH:

Follicle- Stimulating Hormone.

• **FUNCTIONS:**

1- It stimulates the ovarian **primary follicles** to develop and become **mature**.

2- Production of **Estrogen** by the **follicular cells**.

FSH makes the simple flat follicular cells become **cuboidal**, then **columnar** then forming many layers around the oocyte forming **primary follicle**.

*check out the previous image

Ovulatory Phase

The follicle becomes **enlarged** until it gets maturity. It produces swelling on the surface of the ovary.

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

LH:

Luteinizing Hormone.

• **FUNCTIONS:**

1- It serves as **the trigger** for ovulation.

2- Stimulates the follicular cells.

3- Stimulate **corpus luteum** to produce **Progesterone**.

Luteal Phase

The remaining of the ruptured follicle is now called **corpus luteum**.

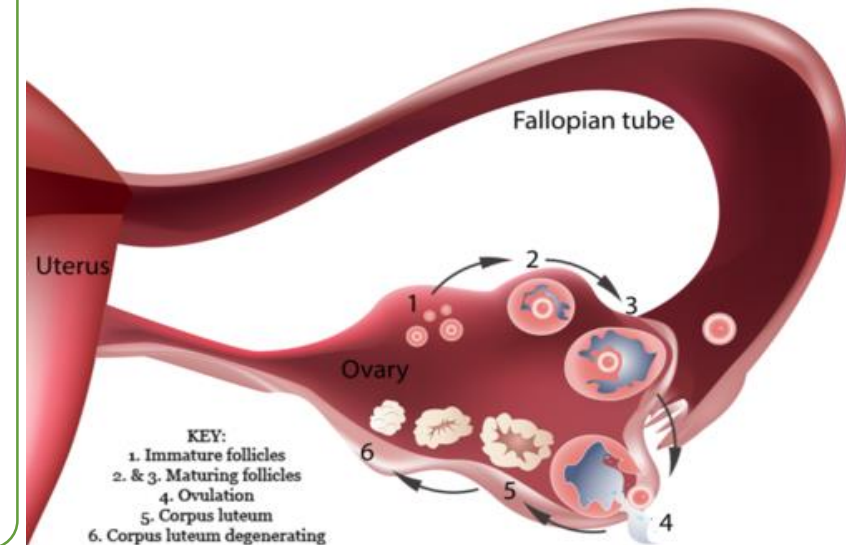
It secretes **Progesterone** and small amount of **Estrogen**.

These 2 hormones stimulate endometrial glands to secrete and prepare **endometrium** for implantation of **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**.

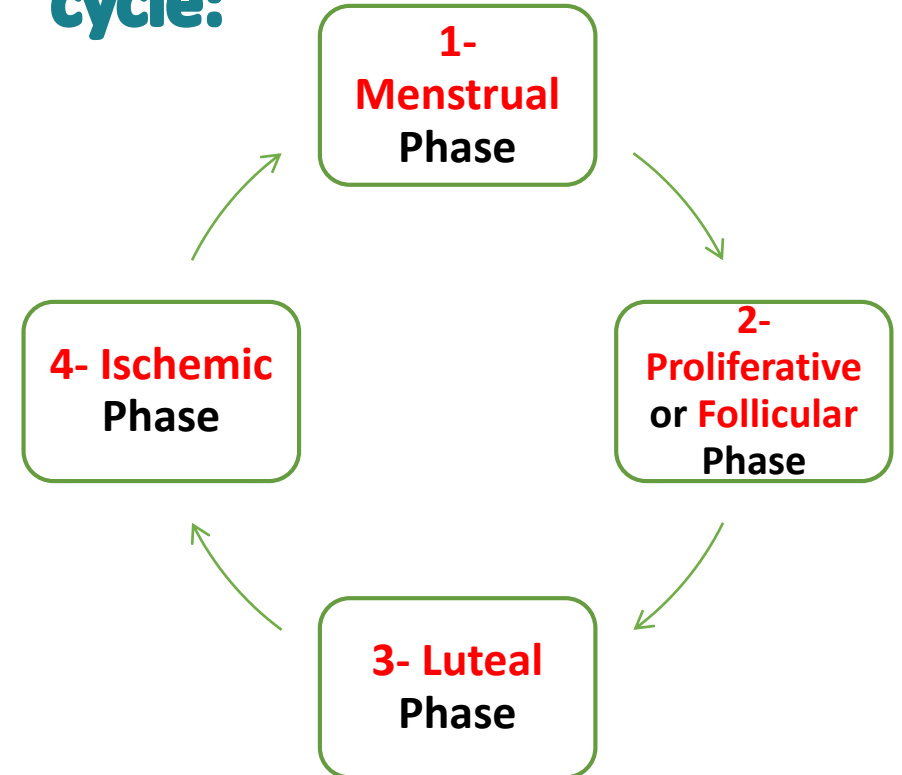
FSH	LH
<p>Early development of ovarian follicle is induced by FSH.</p>	<p>Final stages of maturation require LH. LH causes ovulation (rupture of the mature follicle).</p>



Uterine or Menstrual Cycle:

What is it?	Cyclic changes in the endometrium of the uterus.
What cause it?	Caused by estrogen & progesterone .
It's average days?	An average menstrual cycle is 28 days (the ideal number of days), but it ranges between 23 and 35 days in 90% of women.
What else you need to know about menstrual cycle?	Day one is the day when menstrual blood flow begins. It varies by several days in normal women and It sometimes varies in the same woman.

Phases of the menstrual cycle:



1- 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.**

2- Proliferative Phase:

- Is a phase of **repair and proliferation.**
- Lasts for 9 days.
- Coincides **with growth of ovarian follicle.**
- So it is 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.**



4- Ischemic Phase:

- Degeneration of corpus luteum leads to **decrease the levels of estrogen & progesterone.**
- Loss of interstitial fluid.
- Marked **shrinking of endometrium.**
- **Spiral arteries** become constricted.
- **Venous stasis & Ischemic necrosis.**
- **Rupture** of damaged vessel wall.
- Blood seeps into the surrounding connective tissues.
- Loss of 20-80 ml of blood.
- Entire **compact layer** and most of **the spongy layer of endometrium is discarded.**

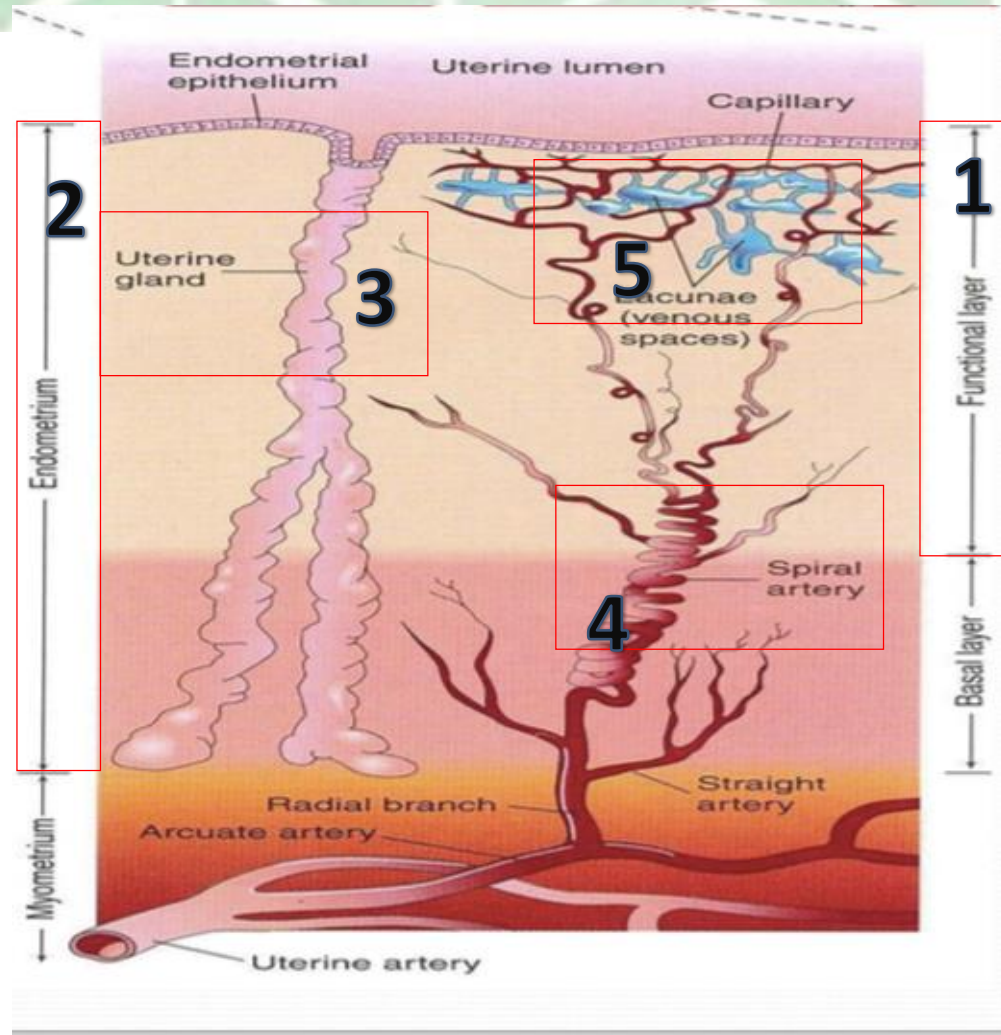
3- Luteal Phase:

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

What happens to the endometrium in this phase?

- The spiral arteries **grow into the superficial layer.**
- Arteries become increasingly **coiled.**
- Large venous network develops.
- Direct **arterio-venous anastomoses** are the prominent features.

FOR YOUR UNDERSTANDING:



- 1** This is the functional layer of the endometrium which slough off and discarded in (**Menstrual Phase**).
- 2** This is the endometrium which **increase in thickness** during (**Proliferative Phase**). Also in (**Luteal Phase**) this endometrium **thickens** under the influence of **progesterone and estrogen**, but it **shrink** in (**Ischemic Phase**).
- 3** This is **the gland which increase in number and length** during (**Proliferative phase**)
- 4** The spiral arteries which **elongate during (Proliferative)** Also it **grow into the superficial layer** during (**Luteal Phase**). In (**Ischemic Phase**) this spiral arteries become constricted.
- 5** This is **the venous network that develops** during (**Luteal Phase**).

Gametogenesis

Definition: It is the production of mature male & female gametes (Sperms & Ova).

Oogenesis:

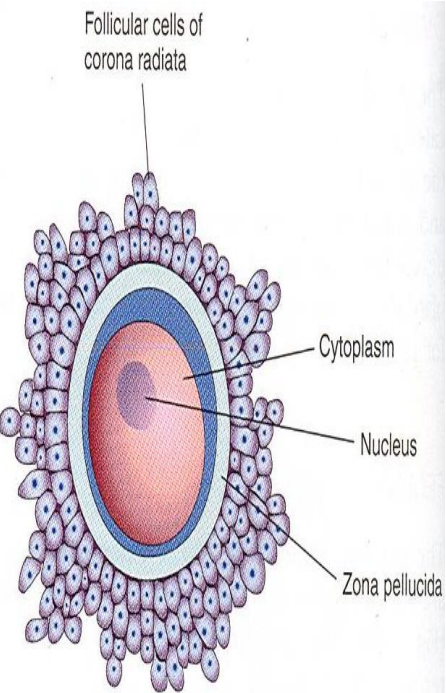
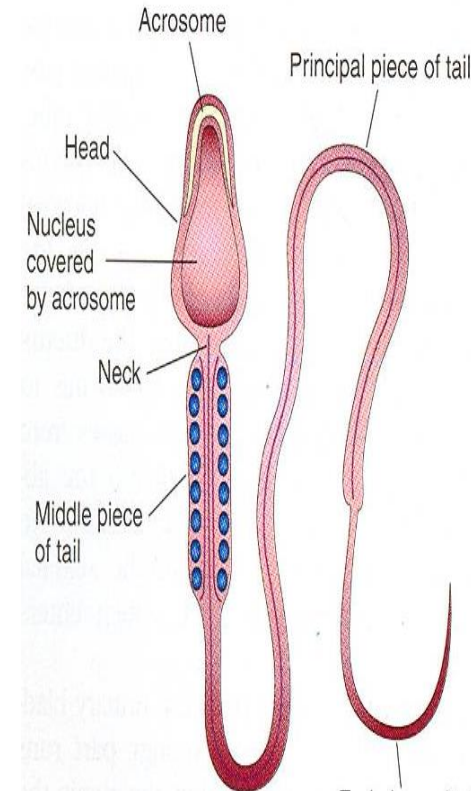
Sequence of events by which the primitive germ cells (**oogonia**) are transformed into mature oocytes.

Note: Mature sperm contain little cytoplasm comparing to mature oocyte

Spermatogenesis:

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

Note:
Spermatogonium (mitosis)
Spermatogonia (grows)



[Video summarizing Gametogenesis](#)

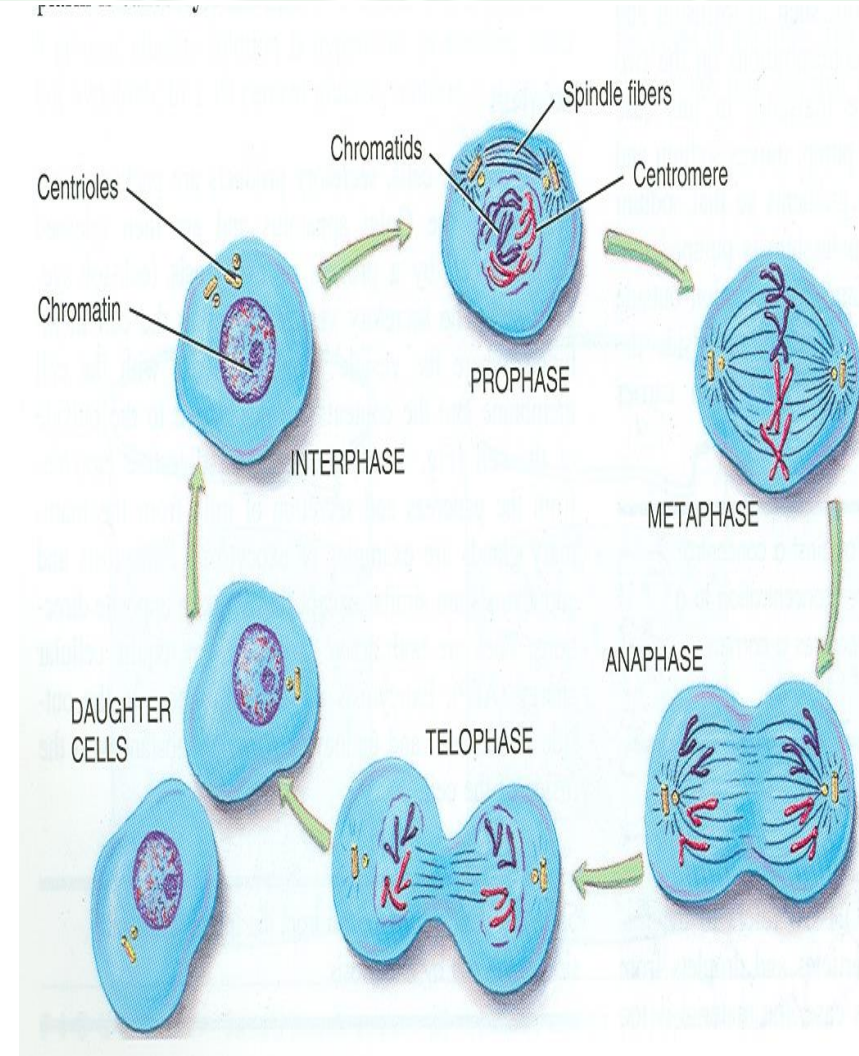
Meiosis

It is the cell division that takes place in the germ cells to produce male & female gametes.

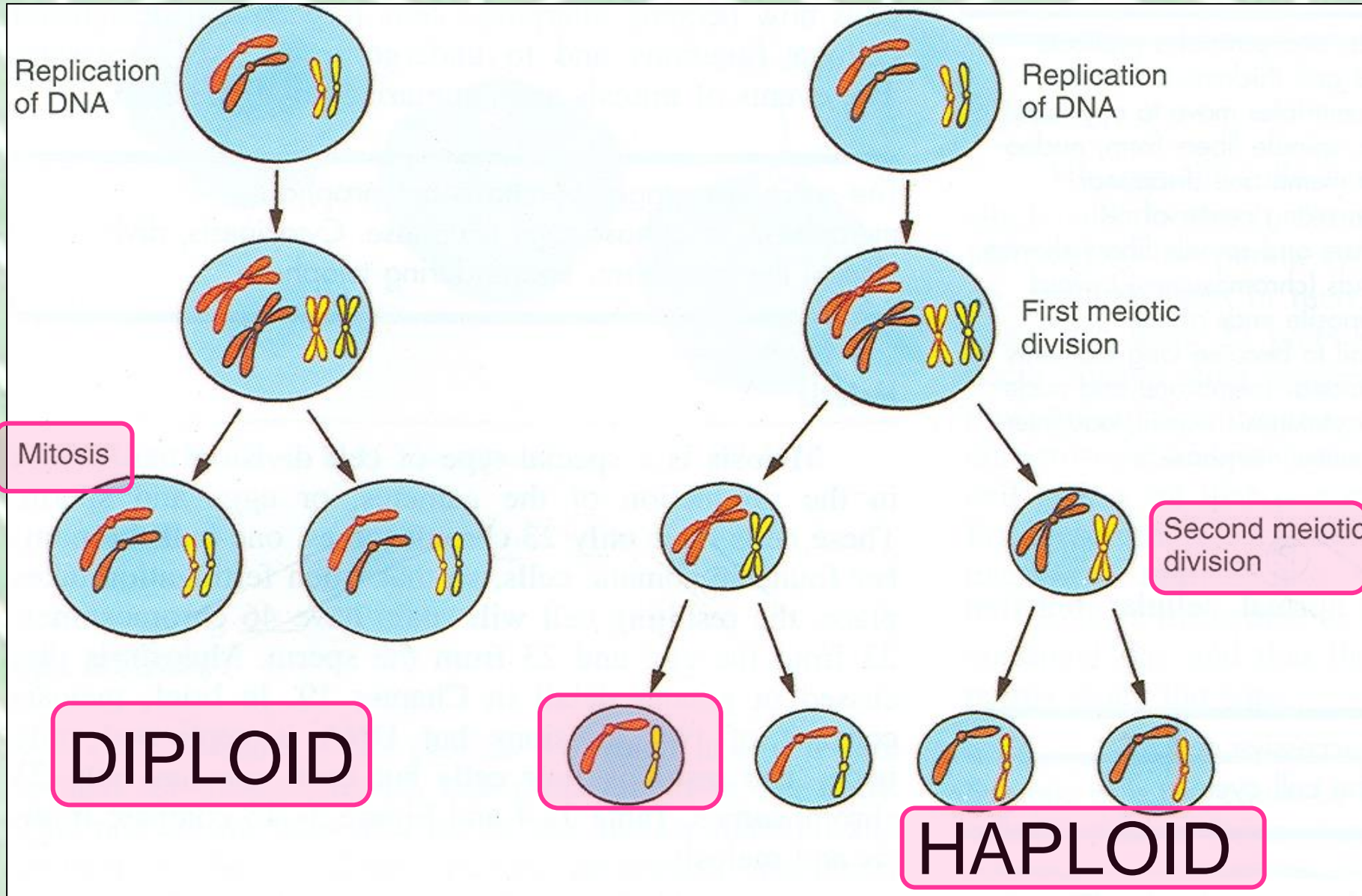
It consists of two cell divisions, **meiosis I & meiosis II** during which the **Diploid** number of chromosomes (46) is reduced **to Haploid** number (23).

First Meiotic division

- At the beginning of **meiosis I**, (**prophase**) male & female germ cells replicate their DNA so that each of **the 46 chromosomes is duplicated into sister chromatid**.
- 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 primary oocyte**.



WHAT IS THE DIFFERENCE BETWEEN MITOSIS & MEIOSIS?



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

N.B. Sperms are stored and become functionally mature in the **Epididymis**.

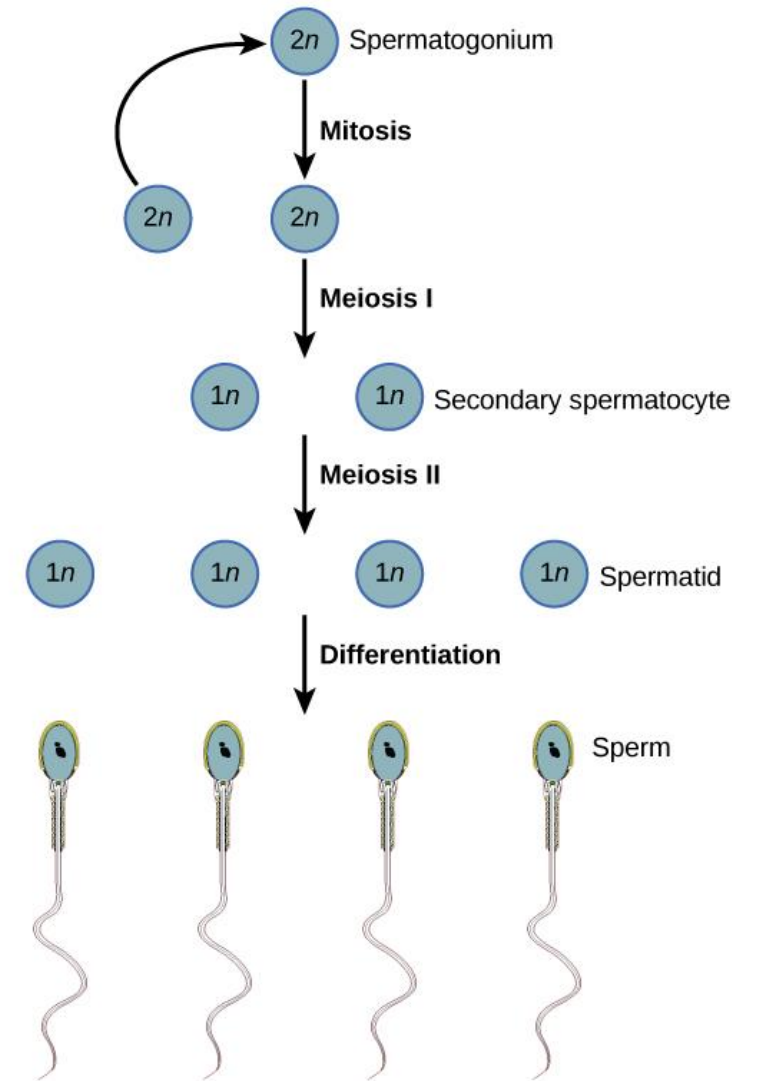
Each daughter **Spermatogonia** grows to give **primary spermatocyte (46)**.

Primary spermatocyte undergoes **meiotic** division to give **2 secondary spermatocyte (22+ x) or (22+y)**.

Secondary spermatocytes undergo **2nd meiotic division** to form **4 haploid spermatids** (half size).

Spermatids are transformed into **4 mature sperms** by a process called **spermiogenesis**.

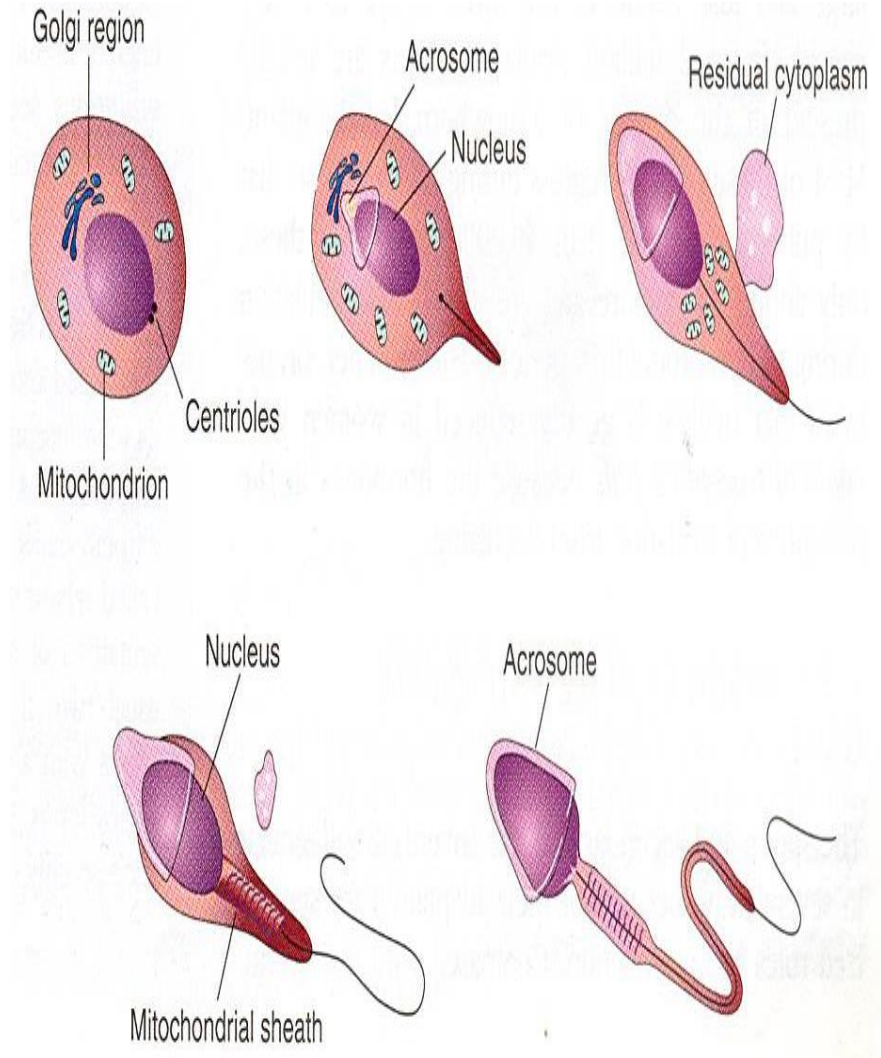
[Video summarizing the spermatogenesis](#)



SPERMIOGENESIS:

It is **change in shape (metamorphosis)** through which Spermatids are **transformed** into mature Sperms:

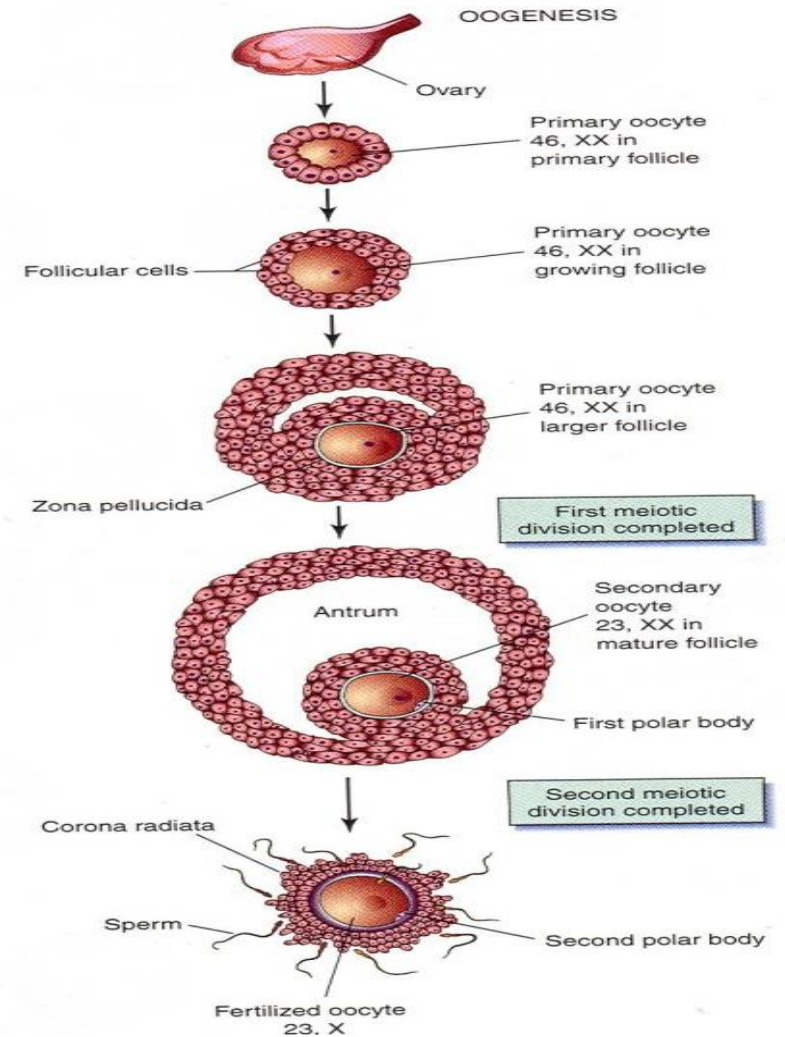
1. **Nucleus** is condensed and forms most of the **head**.
2. **Golgi apparatus** forms the **Acrosome**.
3. **Mitochondria** forms a **spiral sheath**.
4. **Centriole** elongates to form the **axial filament**

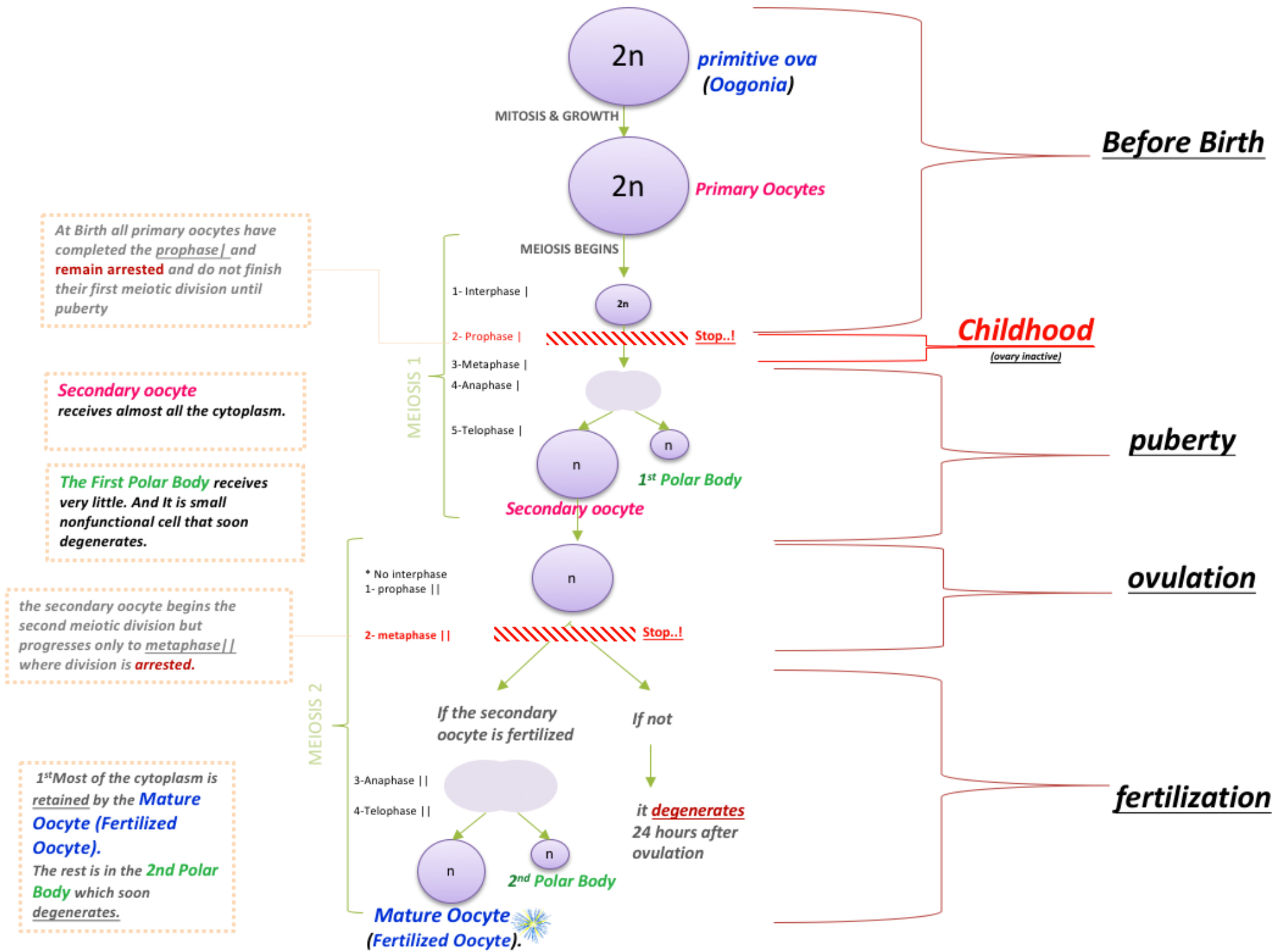


Notice the difference between **spermatogenesis** and **spermiogenesis**!

Oogenesis:

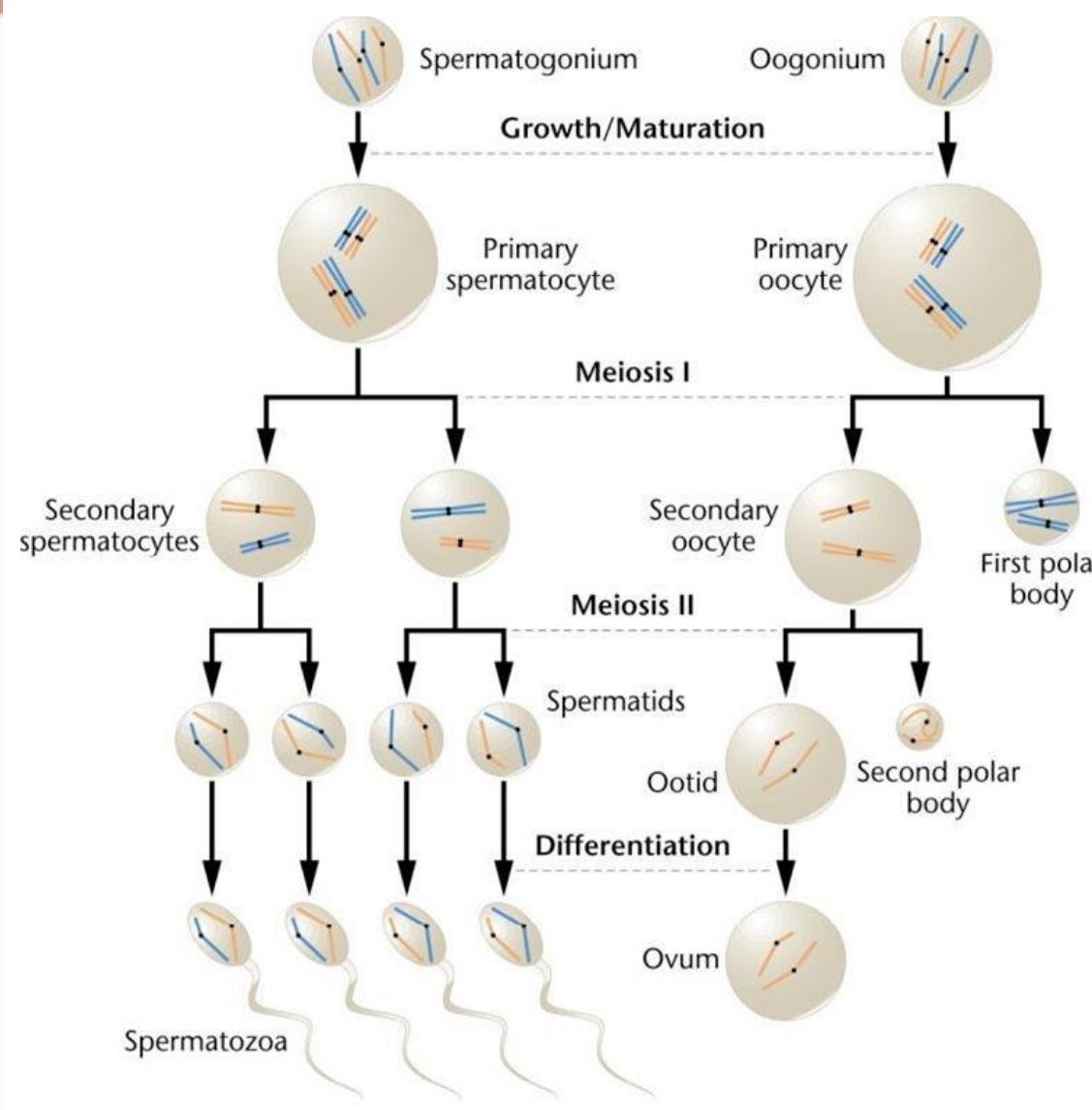
Definition	Sequence of events by which the primitive germ cells (oogonia) are transformed into mature oocytes
Aim	Formation of secondary oocytes with haploid number of chromosomes.
Site	Cortex of the ovary
Time	Starts during fetal life becomes completed after puberty continues until menopause.
Duration	It occurs monthly except during pregnancy.





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

N.B.: NO PRIMARY OOCYTES FORM AFTER BIRTH



Important notes:

- 1- MEIOSIS II, DURING WHICH THE DIPLOID NUMBER OF CHROMOSOMES (46) IS REDUCED TO HAPLOID NUMBER (23).
- 2- GNRH IS SYNTHESIZED BY NEUROSECRETORY IN THE HYPOTHALAMUS
- 3- FSH AND LH ARE SECRETED BY PITUITARY GLANDS.
- 4- LH HORMONE MAKES OVULATION.
- 5- GROWING FOLLICLES PRODUCE (ESTROGEN).
- 6- IF THE SECONDARY OOCYTE IS FERTILIZED, THE SECOND MEIOTIC DIVISION IS COMPLETED.
- 7- AT OVULATION THE NUCLEUS OF THE SECONDARY OOCYTE BEGINS THE SECOND MEIOTIC DIVISION.
- 8- ALL PRIMARY OOCYTES HAVE COMPLETED THE PROPHASE.
- 9- EACH OF THE 46 CHROMOSOMES IS DUPLICATED INTO SISTER CHROMATID.

Useful Videos:

[Spermatogenesis and Oogenesis](#)

[KHAN ACADEMY: REPRODUCTIVE SYSTEM](#)

Quizzes:

[GAMETOGENESIS & FEMALE CYCLES 1](#)

[GAMETOGENESIS & FEMALE CYCLES 2](#)

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