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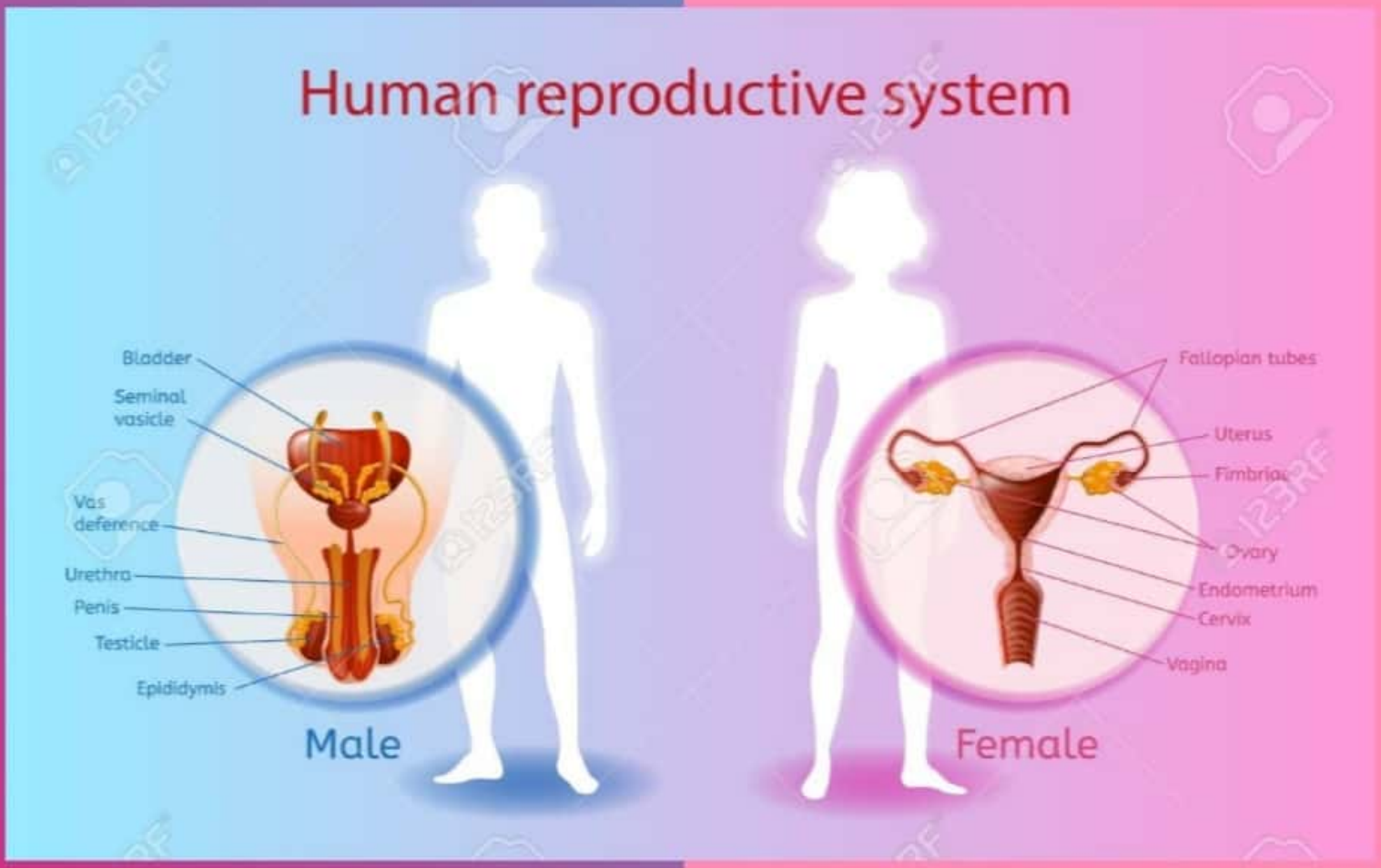


CHAPTER - 3

BIOLOGY

Class -12

GAMETOGENESIS

Definition. Gametogenesis is the process of formation and differentiation of haploid gametes (sperms and ova) from the diploid primary germ cells, **gametogonia (spermatogonia** and **oogonia)** present in primary sex organs called **gonads** (testes in male and ovaries in female respectively).

Types. Gametogenesis is of **two types** :

I. Spermatogenesis and **II. Oogenesis.**

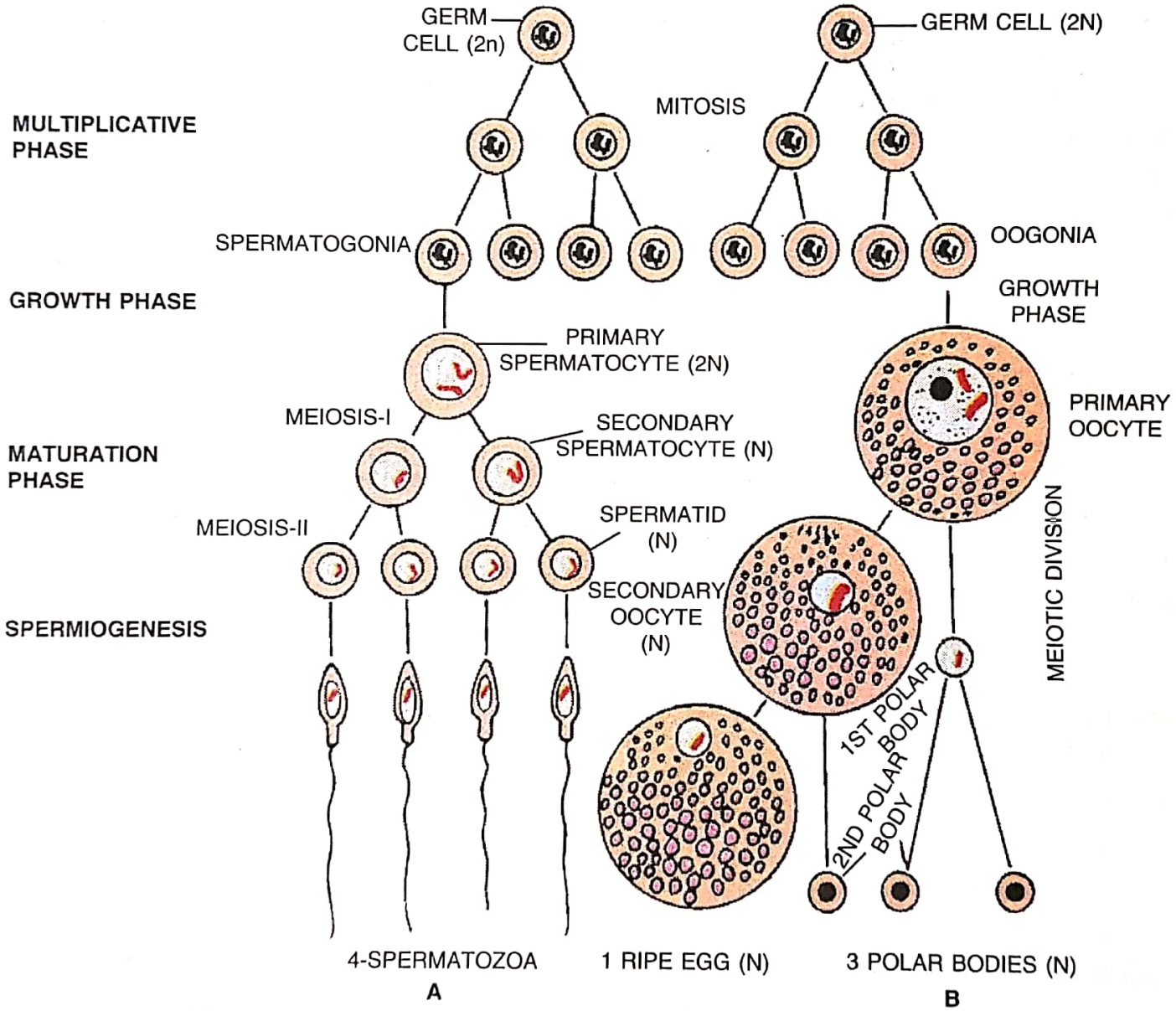


Fig. 3.13. Various stages in gametogenesis. **A.** Spermatogenesis. **B.** Oogenesis.

Spermatogenesis: It is the formation of sperms in the seminiferous tubules lined with germinal epithelium. It takes place in two stages—spermatid formation and spermatozoa formation or spermiogenesis. (Fig. 3.4.)

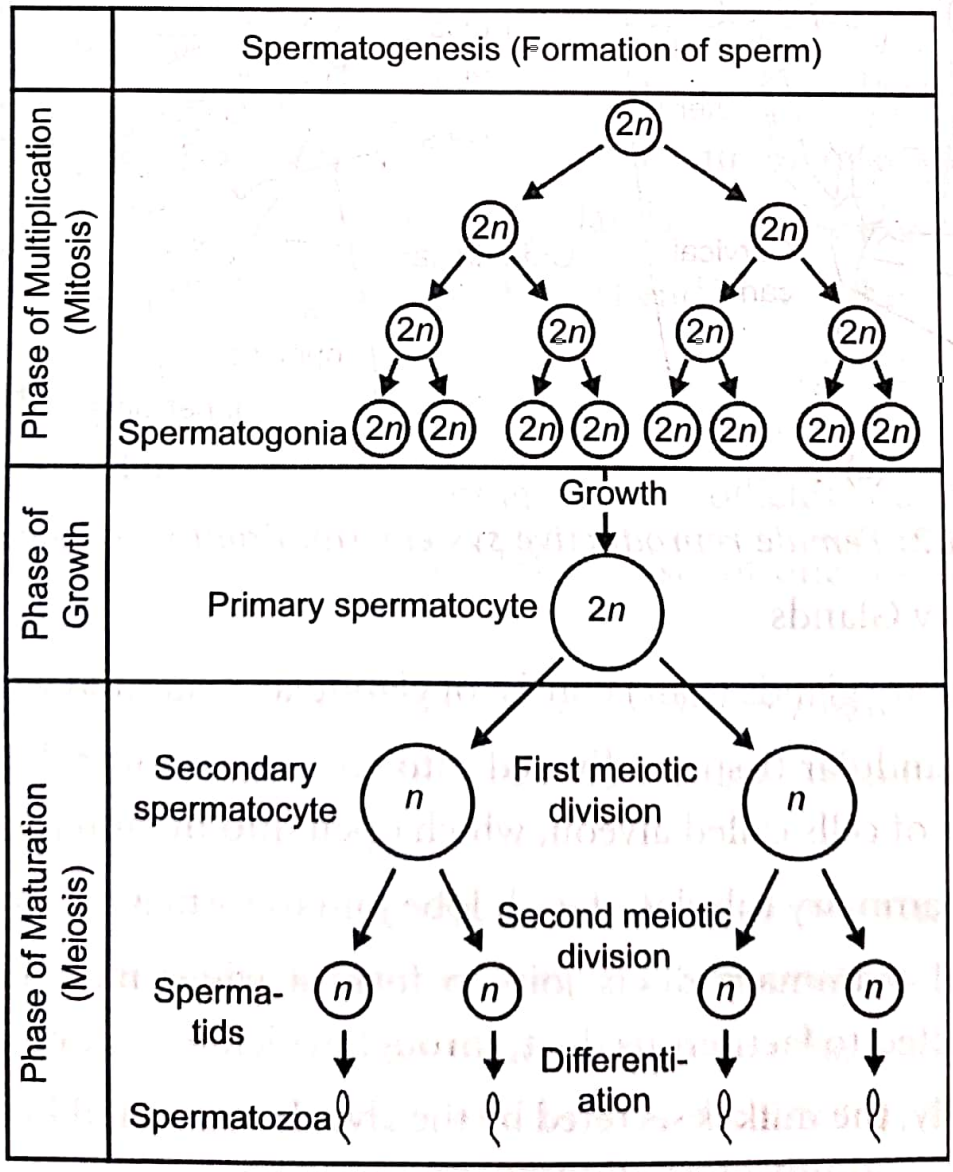


Fig. 3.4: *Spermatogenesis*

(*i*) Spermatid formation takes place through:
(*a*) *Multiplication phase,* (*b*) *Growth phase and* (*c*) *Maturation phase.*

(*ii*) Spermatozoa formation (spermiogenesis) does not involve any further division. It simply involves the movement of cell organelles to the positions characteristic of a mature spermatozoa.

(*iii*) **Spermiation:** The process of release of sperms from the seminiferous tubules is called spermiation.

Structure of Spermatozoa

(*i*) Each sperm or spermatozoa consists of a head, neck, middle piece and tail.

(*ii*) The head contains an acrosome having enzyme **hyaluronidase** that helps in penetration into the ovum, and a sperm nucleus.

(*iii*) The neck contains a **proximal** and a **distal centriole.**

(*iv*) The middle piece consists of axial filament surrounded by tightly coiled spiral sheath of *mitochondria* to provide energy for the motility of sperm.

(*v*) The tail is vibratile and consists of an **axoneme.**

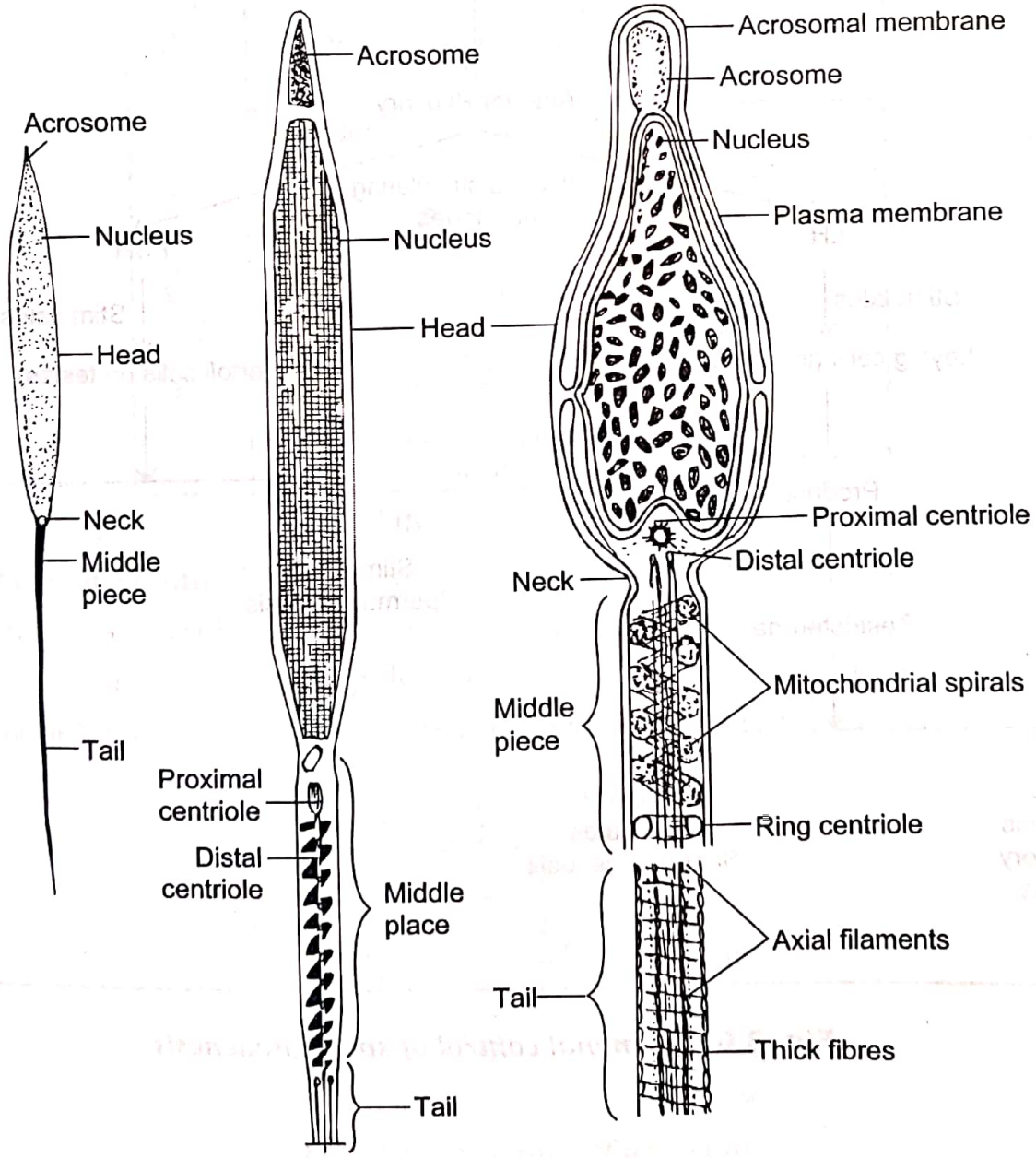


Fig. 3.5: *Mammalian sperm*

Table 3.4. Changes in spermatid to form sperm during spermiogenesis.

Structure of spermatid	Changes in the sperm
1. Nucleus	Shrinks and elongated.
2. Golgi complex	Changes to acrosome.
3. Distal centriole	Forms axial filament of sperm tail.
4. Mitochondria	Form **mitochondrial spiral** of sheath called **nebenkern**.
5. Cytoplasm	Generally lost except a thin sheath called **manchette**.

Hormonal Control of Spermatogenesis

- Spermatogenesis is initiated due to increase in secretion of gonadotropin releasing hormone (GnRH) by the hypothalamus during puberty and later.
- This acts on the anterior pituitary and stimulates secretion of two gonadotropins— Luteinising hormone (LH) and Follicle stimulating hormone (FSH).
- LH acts on Leydig cells stimulating them to release testosterone.
- FSH acts on sertoli cells whose secretions help in spermatogenesis.

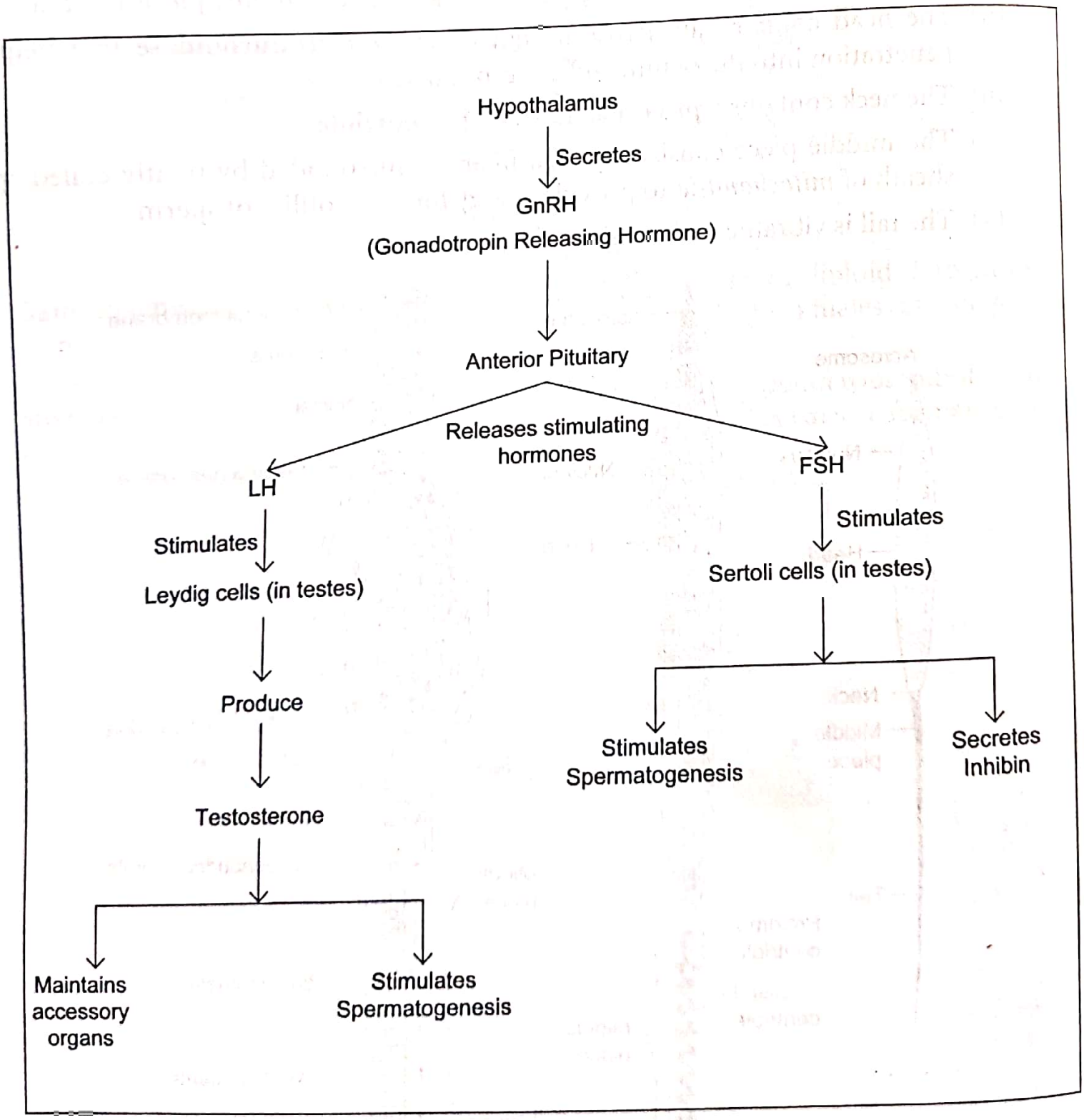


Fig. 3.6: *Hormonal control of spermatogenesis*

Control (Fig. 3.6). In human male, spermatogenesis starts only at puberty due to increased secretion of gonadotropin releasing hormone **(GnRH)** from the hypothalamus of brain. GnRH stimulates adenohypophysis to secrete two **gonadotropins** : FSH and LH (also called ICSH in male). LH stimulates the Leydig's cells of testis to secrete male sex hormones, called **androgens,** most important of which is **testosterone.** Testosterone stimulates the spermatogenesis especially spermiogenesis. FSH stimulates the sertoli cells of testis to secrete certain factors which helps in the process of spermiogenesis. It is called **physiological control.**

Types. In man and a large number of other animals having XY mechanism in male, there are two types of sperms : 50% **Gynosperms** having X-Chromosome and 50% **Androsperms** having Y-Chromosome.

Significance :

(a) Produces haploid sperms.

(b) Crossing over may occur during meiosis-I, so producing variations.

(c) Proves evolutionary relationship.

Oogenesis: The formation of ova is called **oogenesis**. This process also takes place in two stages—ootid formation and ovum formation.

(*i*) As illustrated in the schematic, Fig. 3.7 ootid formation also takes place in three phases: (*a*) *Multiplication phase,* (*b*) *Growth phase and* (*c*) *Maturation phase.*

(*ii*) Ovum formation involves metamorphosis of ootid and three polar bodies disintegrate.

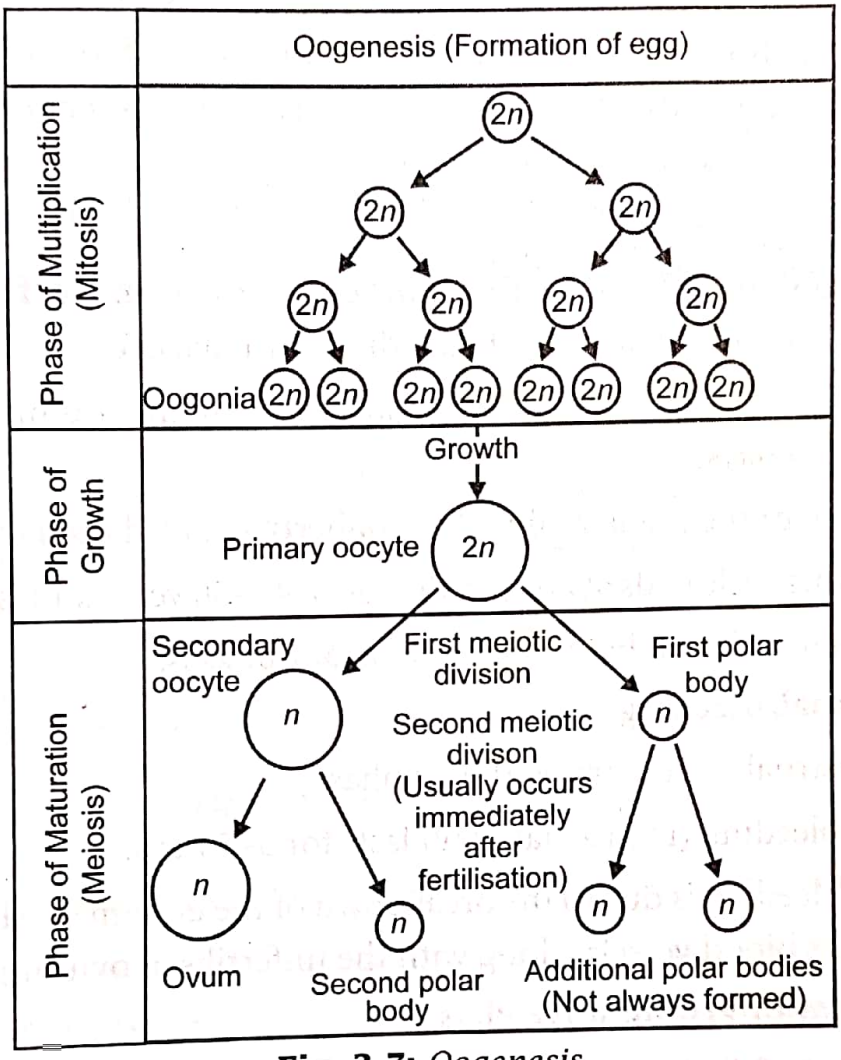


Fig. 3.7: *Oogenesis*

Structure of Ovum: A mature ovum is larger than any other cell in the body. The human egg is microlecithal, *i.e.*, with hardly any yolk. It is a polarised structure with an animal pole and a vegetal pole. It consists of an inner **zona pellucida** and an outer **corona radiata**. The egg membrane is known as **vitelline membrane.**

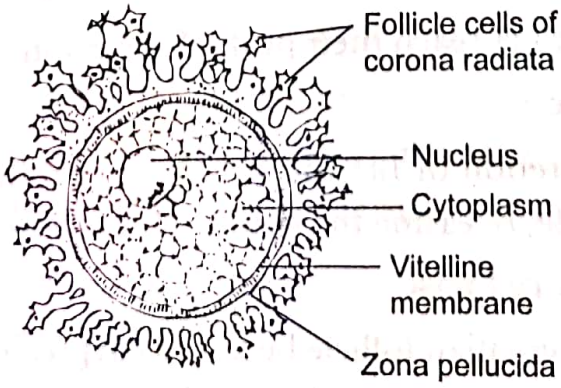


Fig. 3.8: *Structure of an ovum*

Egg envelopes. Human ovum is surrounded by a number of egg envelopes :

1. Vitelline membrane : It is inner, thin, transparent and is secreted by ovum itself.

2. Zona pellucida. It is middle, thick, transparent and non-cellular. It is secreted partly by follicular cells and partly by the oocyte.

3. Corona radiata. It is outer, thicker coat formed of radially elongated follicular cells.

Between the vitelline membrane and zona pellucida, there is a narrow **perivitelline space.**

So in oogenesis, a diploid oogonium forms one **haploid ovum and two or three polar bodies** while in **spermatogenesis, a diploid spermatogonium** forms **four haploid sperms.** The primary function of formation of polar bodies is to bring haploidy but to retain the whole of the cytoplasm in one ovum to provide food during the development of zygote to form an embryo. The number of ova is reduced with the ability of the female to bear and rear them.

In most of organisms including human female, the ovulation occurs at secondary oocyte stage in which

meiosis-I has been completed and first polar body has been released. Meiosis-II is stopped at Metaphase-II and is completed only at the time of sperm-entery.

Significance :

(a) It produces haploid ovum by releasing 2 or 3 haploid polar bodies.

(b) Most of cytoplasm is retained in functional ovum.

(c) Variations may appear due to crossing over during Meiosis-I.

(d) Proves evolutionary relationship.

Hormonal Control of Oogenesis

(*i*) Hypothalamus releases GnRH. It triggers the onset of FSH which in turn stimulates the release of estrogen.

(*ii*) The estrogen then exerts feedback control over the pituitary, so that secretion of FSH is stopped and that of LH begins.

(*iii*) LH stimulates ovulation, corpus luteum formation and progesterone secretion.

(*iv*) The progesterone inhibits ovulation. However, if there is no fertilisation, progesterone level drops, corpus luteum disintegrates, endometrium breaks and menstruation begins.

COMPARE SPERMATOGENESIS AND OOGENESIS

Similarities. 1. Both occur in gonads.

2. Both are concerned with the formation of haploid gametes.

3. Both are divided in three phases : multiplicative, growth and maturation phase.

4. Both are vital in sexually reproducing organisms.

5. In both, the changes occur at nuclear as well as cytoplasmic level.

Table 3.5. Differences between Spermatogenesis and Oogenesis.

Characters	Spermatogenesis	Oogenesis
1. Site of occurrence	In the seminiferous tubules of testes.	In the ovaries.
2. Total period	It is a continuous process and completed in 74 days in humans.	It is a discontinuous process and completed in a few days to years.
3. Growth phase	Of shorter duration.	Of longer duration.
4. Yolk synthesis	No yolk is synthesized in growth phase.	Vitellogenesis occurs in growth phase.
5. Nuclear changes	Nucleus becomes condensed by the loss of superfluous materials.	Nucleus is bloated due to increase in nucleoplasm.
6. Number of gametes	One spermatogonium forms 4 haploid sperms.	One oogonium forms only one ovum.
7. Polar bodies	Not formed.	Two or three polar bodies are formed.
8. Site of completion	It is started and completed within the testes.	It is started inside the ovary but is generally completed outside the ovary.
9. Size of gametes formed	Sperm is much smaller than spermatogonium.	Ovum is much larger than oogonium.

Menstrual Cycle

- Cyclic changes that occur in the reproductive organs of female primates like monkeys, apes and humans, constitute the menstrual cycle.
- The cycle of events starts from one menstruation, till the beginning of next and lasts for about 28/29 days.
- The beginning of the menstrual cycle at puberty is called **menarche.**
- In humans, this cycle ends at around the age of 45–50 years and is called **menopause.**
- The menstrual cycle can be studied under four phases:

(*i*) **Menstrual/Bleeding Phase**

- Menstrual cycle starts with this phase.
- The bleeding (menstrual flow) lasts for 3–5 days.
- The bleeding is due to the breakdown of the endometrial lining of the uterus and its blood vessels, along with the unfertilised ovum.

(*ii*) **Follicular or Proliferative Phase**

- Primary follicles in the ovary grow and become mature Graafian follicles.
- Endometrium is regenerated due to multiplication of cells.
- These changes are due to increased level of certain hormones—pituitary hormones (FSH and LH) and ovarian hormone (estrogen).
- FSH controls the growth of follicles. The growing follicles secrete estrogen.
- Both FSH and LH reach their peak of secretion on 14th day.

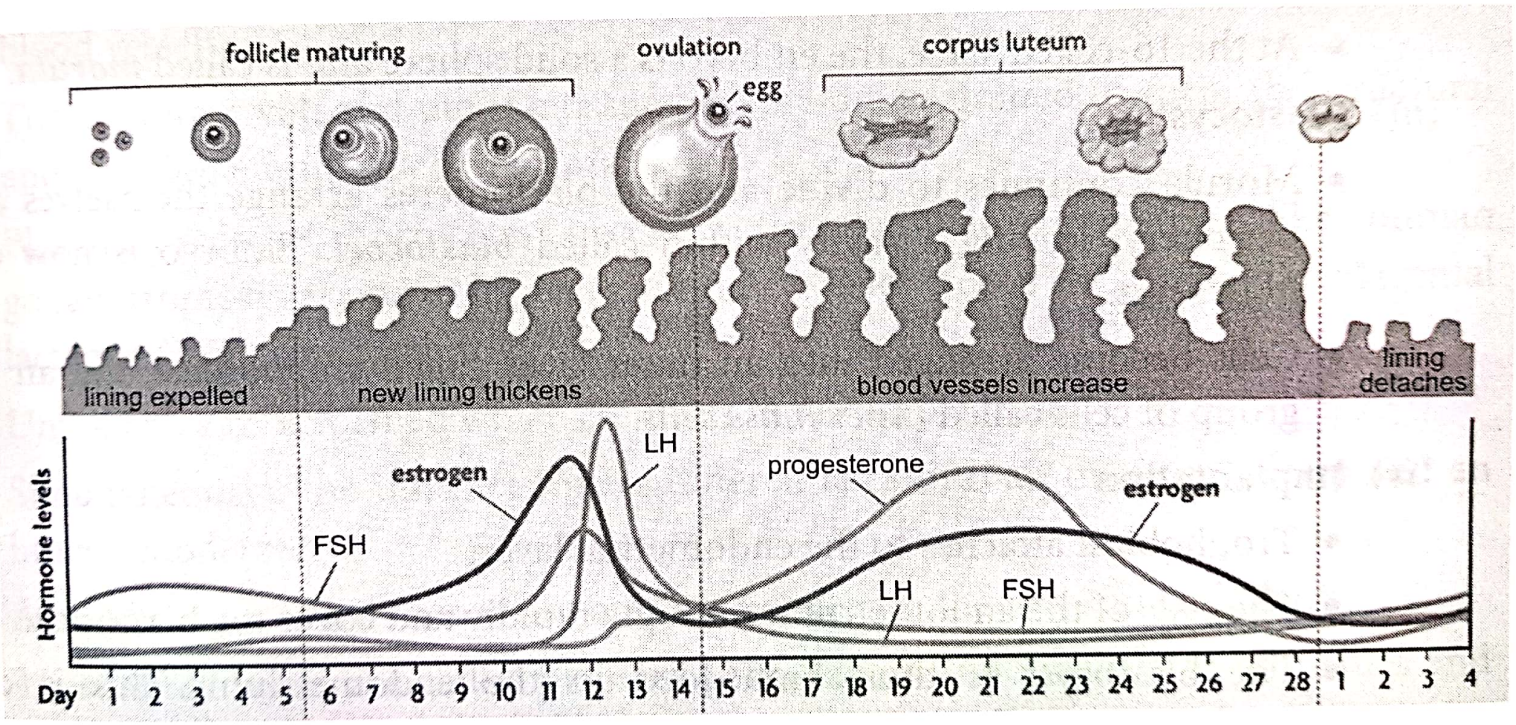
(*iii*) **Ovulatory Phase**

- Peak level secretion of LH called **LH surge** induces rupture of the mature graafian follicle, releasing the ovum. This is known as **ovulation.**

(*iv*) **Luteal or Secretory Phase**

- The ruptured graafian follicle becomes **corpus luteum.**
- Corpus luteum secretes progesterone.

- Endometrium becomes thicker and their glands secrete a fluid into the cavity.
- If there is no fertilisation— corpus luteum degenerates causing degeneration of endometrium leading to menstruation.



1 Bleeding Phase
Uterus lining and some blood flow out of the body.

2 Follicular Phase
Increase in FSH and LH causes ovulation; increase in estrogen causes lining of uterus to thicken.

3 Luteal Phase
Release of progesterone and estrogen stops production of FSH and LH and increases blood vessels in the lining of the uterus.

Next Cycle Begins
Lining detaches and begins to shed again.

Fig. 3.9: *Phases of menstrual cycle*

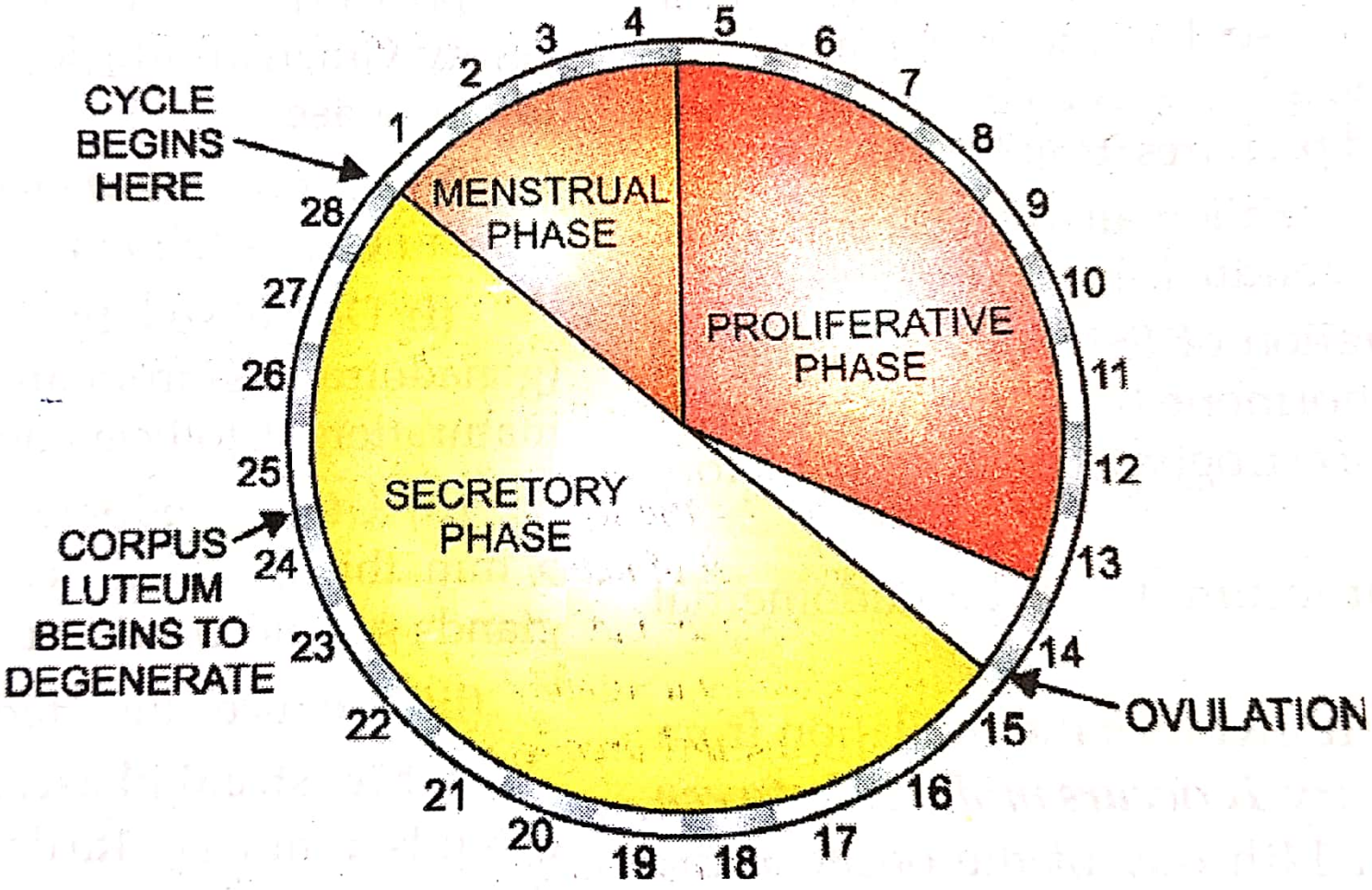


Fig. 3.18. Phases of Menstrual cycle.

OESTROUS CYCLE

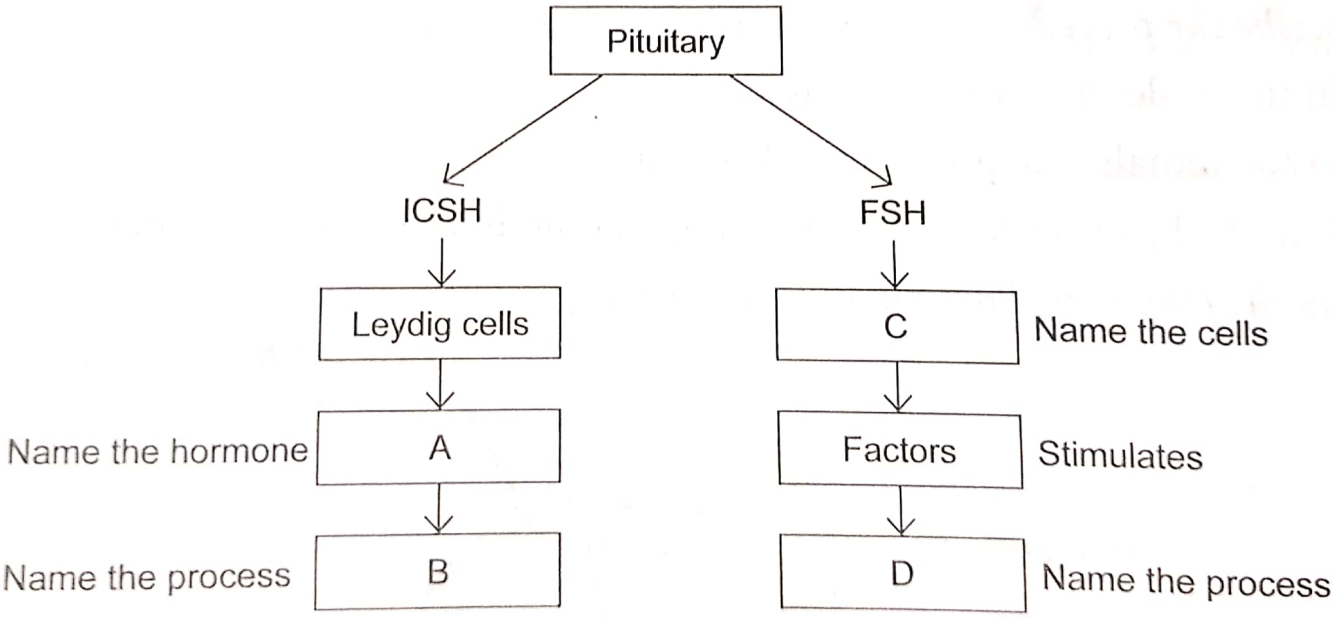
Most of the mammals are seasonal-breeders and breed only in some specific period of the year. In such animals, the female becomes sexually responsive only in a particular season. Breeding season is autumn for sheep, and spring and autumn for bitches. But in some mammals *e.g.*, (cow, buffalo), oestrous cycles occur throughout the year and there is no specific breeding season.

This period of sexual responsiveness of female is called **Oestrous cycle** or **heat period**. This strong sex urge of female is always near the time of ovulation and is due to high blood titre of estrogens. It is generally of short duration *e.g.*, 18 hours in cows. It is generally followed by **anaestrous** or **quiescence** during which the female does not copulate with male.

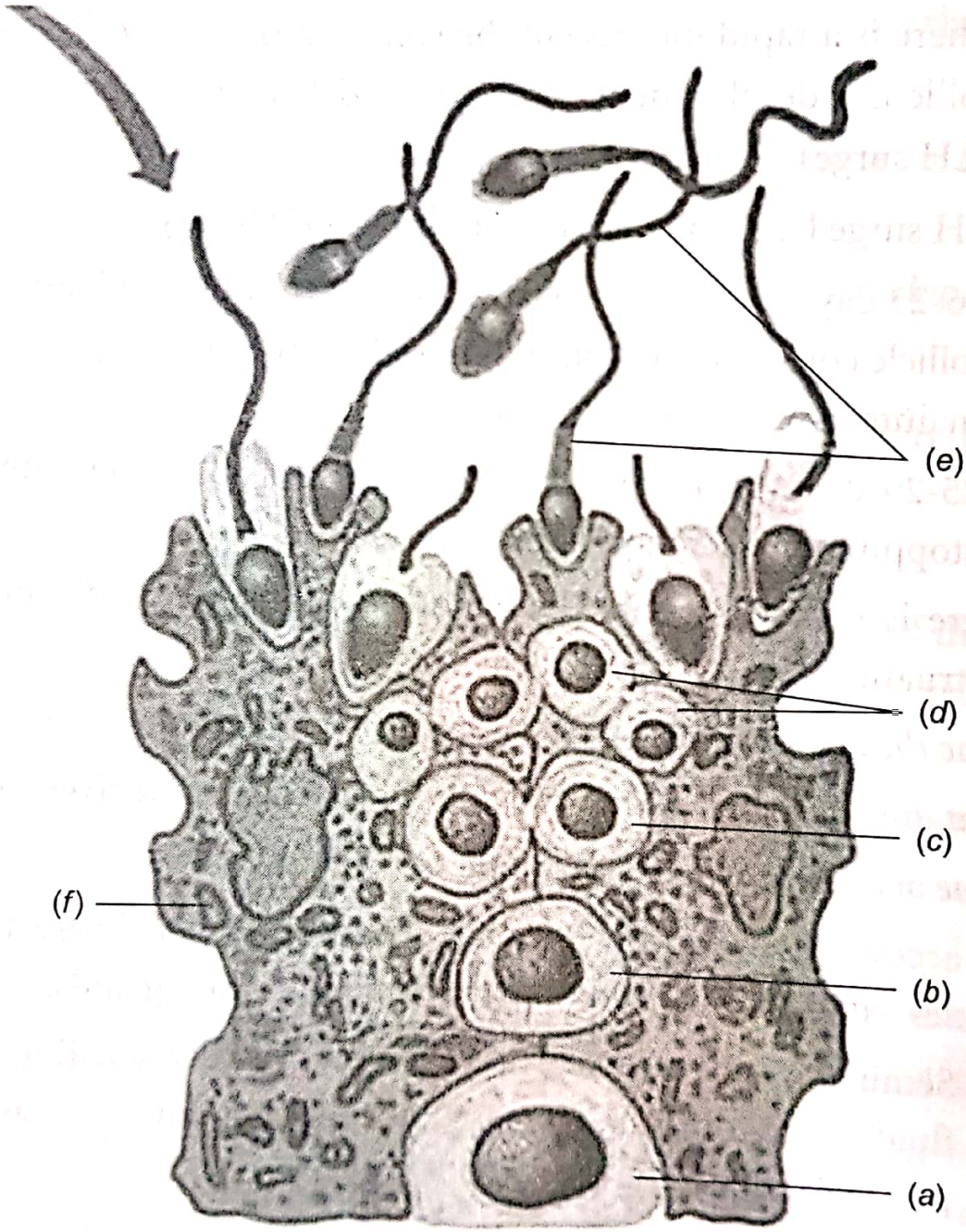
HOME TASK

1. Explain the hormonal control of spermatogenesis & oogenesis with the help of flow charts.
2. Briefly describe the processes of oogenesis & spermatogenesis.
3. Describe testis & ovary with proper diagram.
4. With proper diagram, describe sperm & ova.
5. Define: Capacitation, Acrosome.
6. Give reasons:
   a) Spermatids possess haploid number of chromosomes.
   b) Primary sex organs control the growth, function and maintenance of secondary sex organs.
7. Enumerate the role of hormones in the menstrual cycle.
8. List the changes that occur during spermiogenesis.

Following is an incomplete flow chart showing influence of hormones on gametogenesis. Fill in the blanks A, B, C, D.



. *Study the figure given below:*



(*i*) *Name the cells that undergo spermiogenesis.*

(*ii*) *Name (a) and (b) cells. What is the difference between them with reference to number of chromosomes?*

(*iii*) *Name the motile cells.*

(*iv*) *What are (f) cells? Mention their function.*

(*v*) *The above diagram is a part of which structure?*