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Exam Preparatory Manual for NURSES

OBSTETRICS & GYNECOLOGY

Dharitri Swain

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2 CHAPTER

Fetal Development

LEARNING OBJECTIVES

- Concept of reproduction and reproductive organs
- Reproductive cycles
- Gametogenesis—oogenesis and spermatogenesis
- Structure of mature gametes
- Fetal development process
- Development, structure, and function of placenta
- Placental anomalies
- Fetal circulation
- Umbilical cord and its abnormal variation
- Amniotic fluid and its clinical importance
- Fetal membrane
- Female pelvis and skull

REPRODUCTION

Definition: The process by which a fully developed offspring is produced is known as reproduction.

Reproductive organ: The specialized organs concerned with copulation, fertilization, growth and development of the fetus and its subsequent exit to the outer world are called reproductive organs.

Types of Reproductive Organ

1. *External genitalia (vulva, pudendum) (Fig. 2.1)*

- Mons pubis
- Labia majora
- Labia minora
- Clitoris
- Vestibule
  - External urethral orifice
  - Vaginal orifice
  - Hymen
  - Vestibular bulbs
- Bartholin's glands

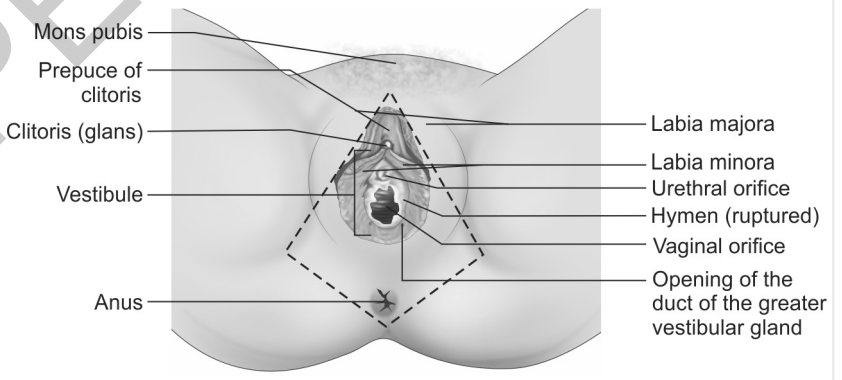

Fig. 2.1: Female external genitalia.

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2. *Internal genitalia (Fig. 2.2)*

- Vagina
- Uterus
- Fallopian tubes
- Ovaries

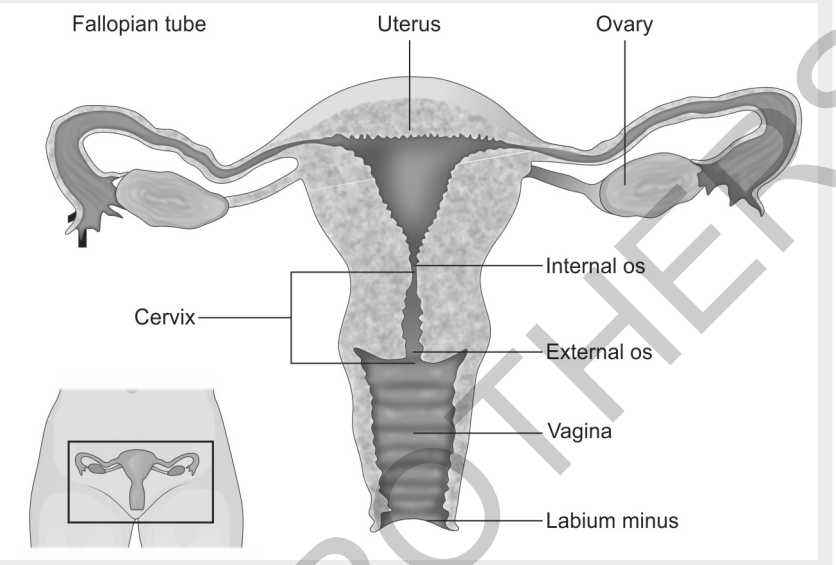

Fig. 2.2: Female internal genitalia.

3. *Accessory reproductive organs (Fig. 2.3)*

- Breast/ mammary glands

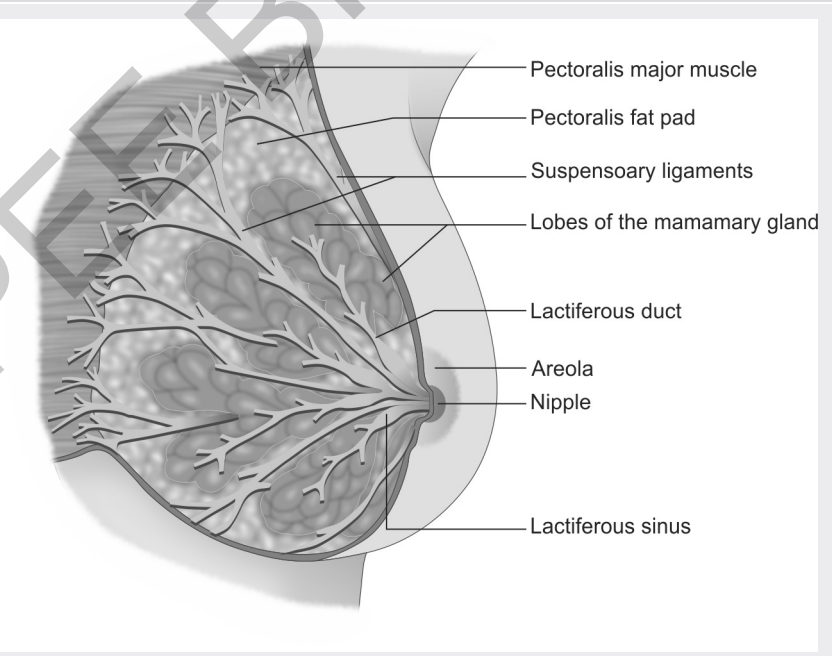

Fig. 2.3: Female breast/mammary glands.

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External Genitalia (Vulva)

External structure	*Structure and important functions*
Mons pubis	**Structure** Fatty pad over the pubic symphysis
Labia majora and minora	**Structure** Folds of skin encircling vestibule where urethral and vaginal openings are found.
Clitoris	**Structure** Small mass of erectile tissue, which is: • Sensitive organ analogous to male's penis • Responsible for stimulating female orgasm
Vestibule	• The region between the labia minora is known as vestibule. • It contains the following parts: ▪ Vaginal and urethral orifices ▪ Vestibular glands—produce mucus to facilitate copulation; analogous to the **bulbourethral glands in males**. ▪ Paraurethral glands—produce mucus to facilitate copulation; analogous to the **prostate gland in males**. ▪ Bulb of vestibule—masses of erectile tissue just deep to the labia on either side of the vaginal orifice
Perineum	An area between the vagina and anus
Bartholin's glands (vestibular glands)	• The Bartholin's glands are located on each side of the vaginal opening. • They secrete fluid that helps lubricate the vagina. • Sometimes the ducts of these glands become obstructed. ▪ Fluid backs up into the gland and causes swelling (Bartholin's cyst)

Internal Genitalia

Internal structure	*Structure and important functions*
Vagina	**Structure** Vagina is the communicating pathway between the uterine cavity and the vulva • **Parts** ▪ Uppermost part—vaginal vault ▪ Lower end—introitus • **Vaginal wall:** Having four walls 1. Anterior wall—7.5 cm 2. Posterior wall—9 cm 3. Two lateral walls • **Vaginal fornices:** Vagina contains four fornices. Fornices are formed at vaginal vault due to projection of uterine cervix into the vagina. **Important functions** • Connects the outer part with the uterus • Provides a passageway for sperm and menstrual flow • Functions as the birth canal
Uterus	**Structure** *Uterine parts:* • Body/corpus • Fundus • Body proper • Isthmus: ▪ Anatomical internal os ▪ Histological internal os • Cervix—ends with external os

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	Measurement of uterus • Length—7.5 cm • Width—5 cm • Thick—2.5 cm • Weight—50 g • Isthmus—0.5 cm • Cervix—2.5 cm **Uterine layers** • Perimetrium • Myometrium **Important functions** • Development of embryo and fetus • Involved in uterine cycle or menstrual cycle
Ovaries	**Structure** Paired sex glands/gonads in female: • Almond shape • Pinkish gray in color **Measurement**—(3 × 2 × 1) cm **Structure** • Outer lining—germinal epithelium • Outer cortex—contains stromal cell, ovarian follicle • Inner medulla—hilus cells (sex hormone) **Important functions** • Produce the hormones estrogen and progesterone • Site of development of oocytes and ovulation
Fallopian tube	**Structure** It is a paired structure: • Length—10 cm • Diameter—0.6 cm **Parts** • Intramural/interstitial • Isthmus • Ampulla • Infundibulum **Important functions** • Also known as oviduct • Carries the ovum from the ovary to the uterus • Fimbria receives and sweeps the ovum into the oviduct following ovulation • Ampullary part of fallopian tube is the site of fertilization

Accessory Reproductive Organs

- Breast/mammary gland
- Modified sweat glands that produce milk (lactation)
- Amount of adipose determines size of breast
- Milk-secreting glands open by lactiferous ducts at the nipple
- Areola is pigmented area around nipple
- Suspensory ligaments suspend breast from deep fascia of pectoral muscles (aging and Cooper's droop)
- Mammary line is a thickened ridge of embryonic that extends from the axilla to the groin.
- Prolactin from the pituitary gland stimulates the synthesis of milk.
- Oxytocin from the posterior pituitary gland stimulates milk ejection.

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GAMETOGENESIS

The process involved in the maturation of the gametes, such as spermatozoon in male and ovum in female, is called gametogenesis. The male and female gametes are united to form future zygote.

- It is of two types such as oogenesis and spermatogenesis.
- Oogenesis is the maturation of ovum and spermatogenesis is the maturation of sperm.

Types

Types of gametogenesis are as follows:

1. **Oogenesis:** The process of formation of mature ovum is called oogenesis **(Fig. 2.4)**.

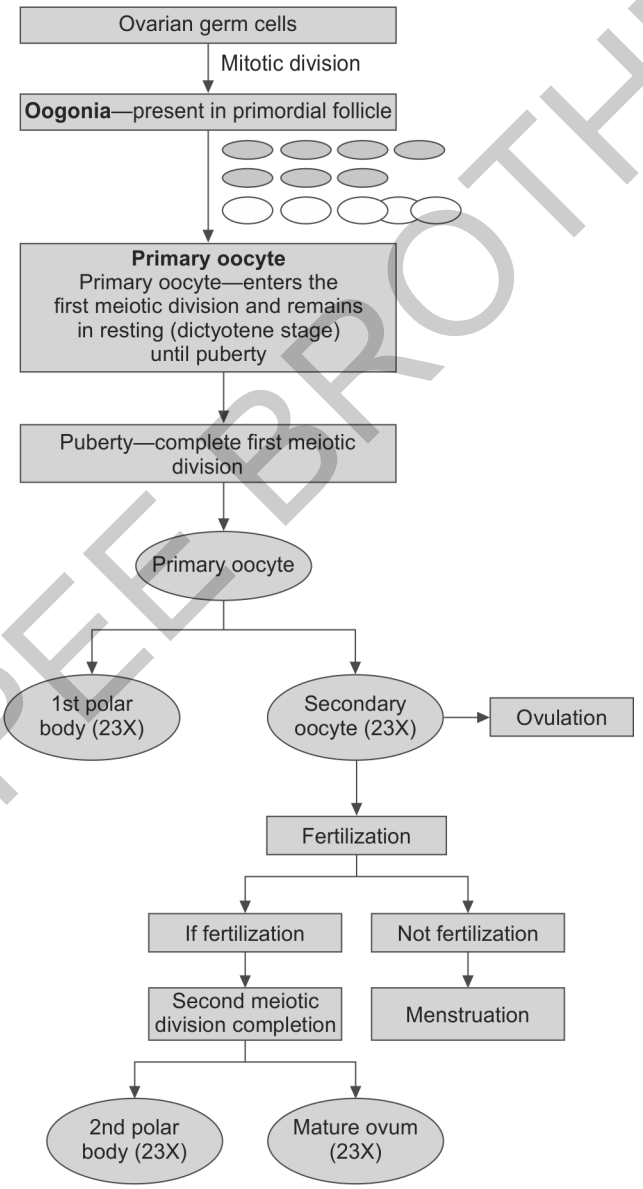

Fig. 2.4: Oogenesis.

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2. **Spermatogenesis (Fig. 2.5):**

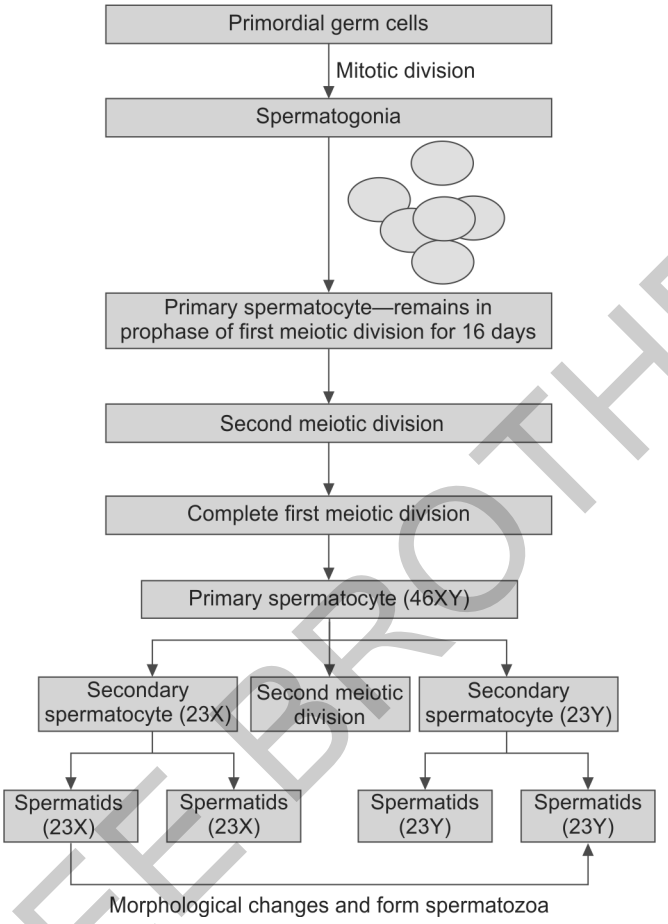

Fig. 2.5: Spermatogenesis.

REPRODUCTIVE CYCLE

Definition: Regular and recurrent changes in the anterior pituitary hormones, ovaries, and uterine endometrium, which are designed to prepare the body for reproduction.

Types

Types of reproductive cycle include:
1. Ovarian cycle
2. Menstrual cycle/endometrial cycle.

Ovarian Cycle

It has three phases:
1. Follicular phase
2. Ovulatory phase
3. Luteal phase.

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Ovarian cycle	*Characteristics and functions*
Follicular phase	• It is the period during which an ovum matures • Hypothalamus • Anterior pituitary • Ovary—stimulates ovarian follicle to grow • Mature Graafian follicle—produces estrogen/estradiol negative feedback effect, so decreases follicle-stimulating hormone (FSH), and produces luteinizing hormone (LH)
Ovulatory phase	• Peak LH on 14th day • Rupture of Graafian follicle (GF) • Release of secondary oocyte (ovulation)—picked by fimbriated end of fallopian tube
Luteal phase	• After ovulation follicle fills with yellow pigment called **corpus luteum (CL)**, it persists for 12 days under the influence of LH • CL produces high levels of progesterone and low levels of estrogen • If there is no fertilization, corpus luteum starts declining due to a decrease in the level of LH • CL degenerated is replaced by fibrous tissue called corpus albicans (white body) on 27th day • Production of estrogen and progesterone decreases and reaches the lowest level, so resulting in **menstruation** • Due to decreased level of LH, there will be negative (–ve) feedback on ovary and increase in FSH and beginning of follicular development

Endometrial Cycle (Menstrual Cycle)

Endometrial cycle (menstrual cycle) is divided into:

1. Proliferative phase
2. Secretary phase
3. Menstrual phase.

Endometrial cycle	*Characteristics and functions*
Proliferative phase	• It occurs in the follicular phase • As the ovarian follicle grows, more amount of estrogen is produced • So reconstruction of endometrium occurs in response to estrogen's secretion of growing follicle • Proliferation of endometrial glands, expansion and multiplication of columnar epithelial cells, and endometrial spiral blood vessels' increase in length • Thickening of endometrial layer from 0.5 to 3.5 mm in thickness
Secretary phase	• It occurs during luteal phases to provide support for the growth of the early embryo due to secretion of progesterone • Progesterone helps in secretary changes in endometrium so that deciduas will form to receive fertilized ovum for implantation • Endometrial glands become tortuous/edematous and expanded; the coiling of the spiral vessels is intensified and becomes more vascular • Endometrial glands secrete a large quantity of glycogens, proteins, lipids, and minerals, which are stored within the endometrium to nourish the fertilized ovum and awaiting arrival of the zygote

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Endometrial cycle	*Characteristics and functions*
Menstrual phase	• When conception does not occur, CL degenerates • Decrease in levels of estrogen and progesterone • Decrease in endometrial changes: ▪ Decrease in blood flow (vasospasm) ▪ Stromal cells disintegrate and endometrial gland secretion diminishes ▪ Degeneration of endometrial cells and bleeding occurs, which is called menstruation • The cycle is called **menstrual cycle** ▪ Duration—4–5 days ▪ Blood loss—30–50 mL ▪ Cycle—28 days ▪ Menstrual discharge contains blood, endometrial debris, enzymes, cervical mucus, desquamated vaginal cells, prostaglandins, bacteria, etc.

STAGES OF DEVELOPMENT OF OVARIAN FOLLICLES

The stages of development of ovarian follicles can be described as follows **(Fig. 2.6)**:

- **Proliferation of stromal cell:** Cortex part of ovary contains stromal cells, which get divided into multiple cells.
- **Follicular follicle:** Stromal cell of cortex is flattened, surrounded the oocyte, and forms some specialized cells known as **follicular cell.**
- **Primordial follicle:** Follicular cells become columnar and form follicles known as primordial follicle.
- **Early preantral follicle:** The size of primordial follicle gradually increases and forms theca outside the follicle, also known as secondary follicle.
- **Antral follicle:** The size of secondary follicle gradually increases and forms small cavity or antrum, also known as tertiary follicle.
- **Preovulatory Graafian follicle:** Lastly, mature follicles are developed in which oocyte is surrounded by big antrum, known as GF.

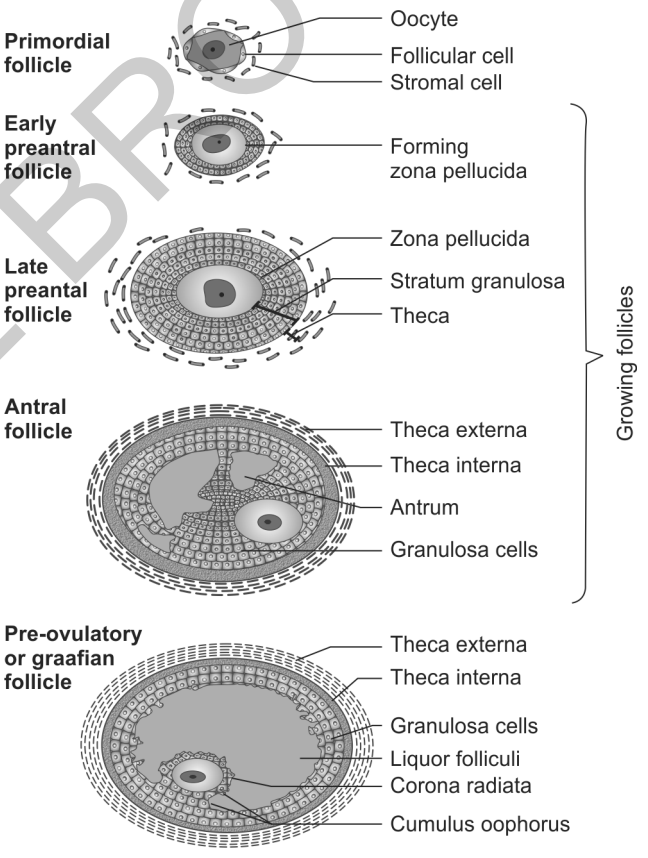

Fig. 2.6: Stages of mature ovarian follicle development.

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STRUCTURE OF MATURE OVARIAN FOLLICLE

The structure of mature ovarian follicle/Graafian follicle (GF) includes **(Fig. 2.7)**:

- A membrane appears between follicular cell and oocyte is known as **zona pellucida.**
- Follicular cell proliferates to form many cells called granulosa cell, which forms the layers called **membrane granulose.**
- An antrum/cavity appears within the membrane granulosa is known as **follicular cavity.**
- Follicular cavity increases in size; oocyte placed eccentrically and surrounded by **cumulus oophoricus,** which is placed toward the center and some cells toward follicular wall are known as **discus proligerus**.
- Stromal cell outside the membrane granulosa becomes condensed and forms **theca interna** and outer most part forms **theca externa.**

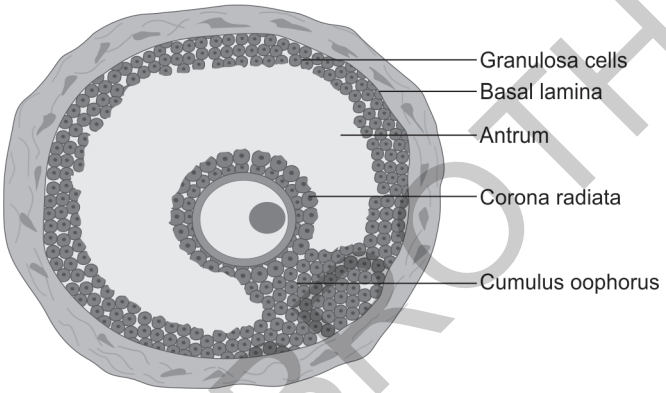

Fig. 2.7: Structure of the graafian follicle.

OVULATION

Ovulation is the process of releasing secondary oocyte from Graafian follicule and becomes available for conception.

- Only one secondary oocyte in one ovarian cycle.
- Ovulation remains suspended during pregnancy and lactation.

Process

Following are the steps included in the ovulation process:

- Accumulation of follicular fluid—Graffian follicule (GF) enlarges .
- Cumulus oophorus separates from granulosa cells and floats in antrum.
- Follicular wall becomes thinner and develops conical projection called stigma, which penetrates the outer surface of ovary.
- Oocyte comes out with follicular fluid and cumulus.

Effects

Effects of ovulation are as follows:

- Following ovulation, the cytoplasm of follicle becomes filled with yellow pigment called lutein, so it gives the structure of yellow color called **CL (yellow body)**.
- If the ovum is not fertilized, CL persists for about 12–14 days and secretes progesterone, known as CL of menstruation and then degenerates to form a mass of fibrous tissue called the **corpus albicans (white body)**.

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- If the ovum is fertilized, CL persists for 3–4 months and larger than CL of menstruation and is called CL of pregnancy, which is essential for the maintenance of pregnancy in early month.

Hormonal Control

To control hormone, the following two processes are involved:

1. **FSH surge:** FSH helps in maturation of follicles and maturation of oocyte.
2. **LH surge:** Luteinizing hormone helps in ovulation.

STRUCTURE OF MATURE GAMETES

Structure of Ovum (Fig. 2.8)

Mature ovum is the largest cell in body—130 μm in diameter.

It contains:

- Chromosome—haploid no (23X), cytoplasm, nucleus.
- The membrane surrounds ovum called **vitelline membrane**.
- The outer transparent layer is called **zona pellucida**.
- Space appears between vitelline membrane and zona pellucida, which accommodates polar bodies called **perivitelline space**.
- After ovulation, ovum retains a covering of granulosa cell, i.e., cumulus oophoricus called **corona radiata**.

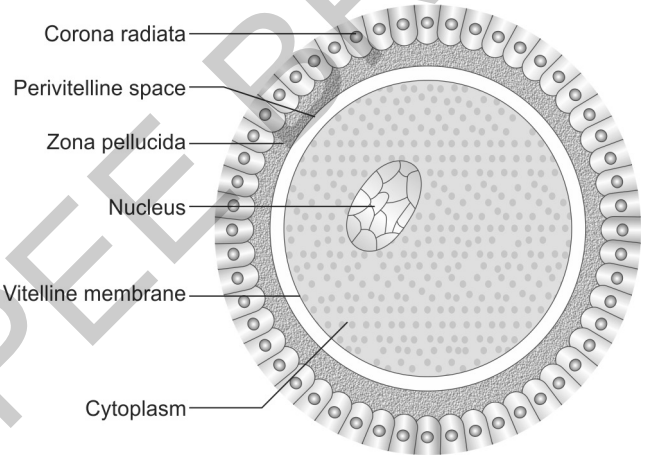

Fig. 2.8: Structure of ovum.

Structure of Mature Spermatozoon (Fig. 2.9)

Parts of spermatozoon	*Characteristics*
Head	• Maximum length—4 μm • Diameter—3 μm • Contains—little cytoplasm and elongated nucleus • Acrosomal cap—contains acid phosphates, hyaluronidase enzyme, neuraminidase, and proteases • Connected with tail by a short constricted neck

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Parts of spermatozoon	*Characteristics*
Neck	• Length—0.3 µm • At the center, there are centriole and small amount of cytoplasm, covered by a plasma membrane continuous with head and tail
Tail	Three parts: 1. **Middle piece** ▪ Long cylinder—7 µm long ▪ It consists of microtubules, axoneme surrounded by a mitochondrial sheath 2. **Principal piece** ▪ Middle part, 40 µm long ▪ It forms majority of the spermatozoon 3. **End piece** ▪ 5.7 µm long ▪ No outer fiber sheath, only axoneme ▪ Has flagellum, moves 20 cm/h

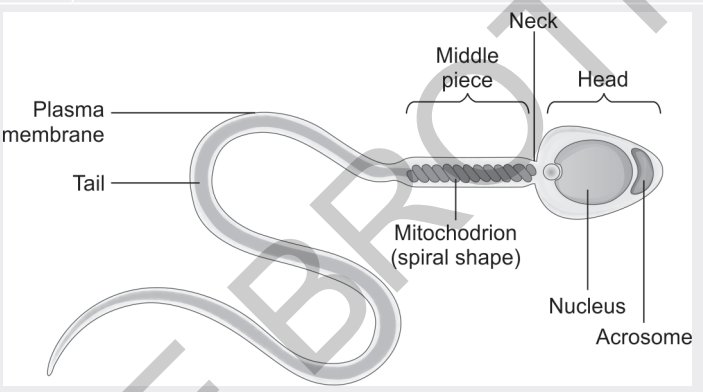

Fig. 2.9: Structure of spermatozoon.

Capacitation

Physiological changes occur in the sperm to make it capable of fertilizing the ovum is known as capacitation. It occurs in fluid media of female genital tract, takes 2–6 hours. The following changes occur after capacitation:

- Decreases DNA core in nucleus
- Removal of glycoprotein coat and plasma proteins from plasma membrane over acrosome and acrosomal reaction occurs

FETAL DEVELOPMENT PROCESS

Stages of fetal development	*Duration*
Fertilization	0 h
Blastomere (2-cell stage)	30 h
4-cell stage	40–50 h
Morula stage (16-cell stage)	Days 2 and 3
Formation of blastocyst	Days 4 and 5
Implantation	Day 6
Development of decidua	Second week
Formation of bilaminar and trilaminar disks	Third week

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Stage 1: Fertilization

Definition: The process of fusion of the spermatozoon with mature ovum and formation of mononucleated single cell is called zygote.

It takes 24 hours and occurs at the ampullary part of uterine tube.

Steps

Steps of fertilization are as follows **(Fig. 2.10)**:

- Ovulation occurs and ovum picked by tubal fimbria.
- Sperm undergo capacitation.

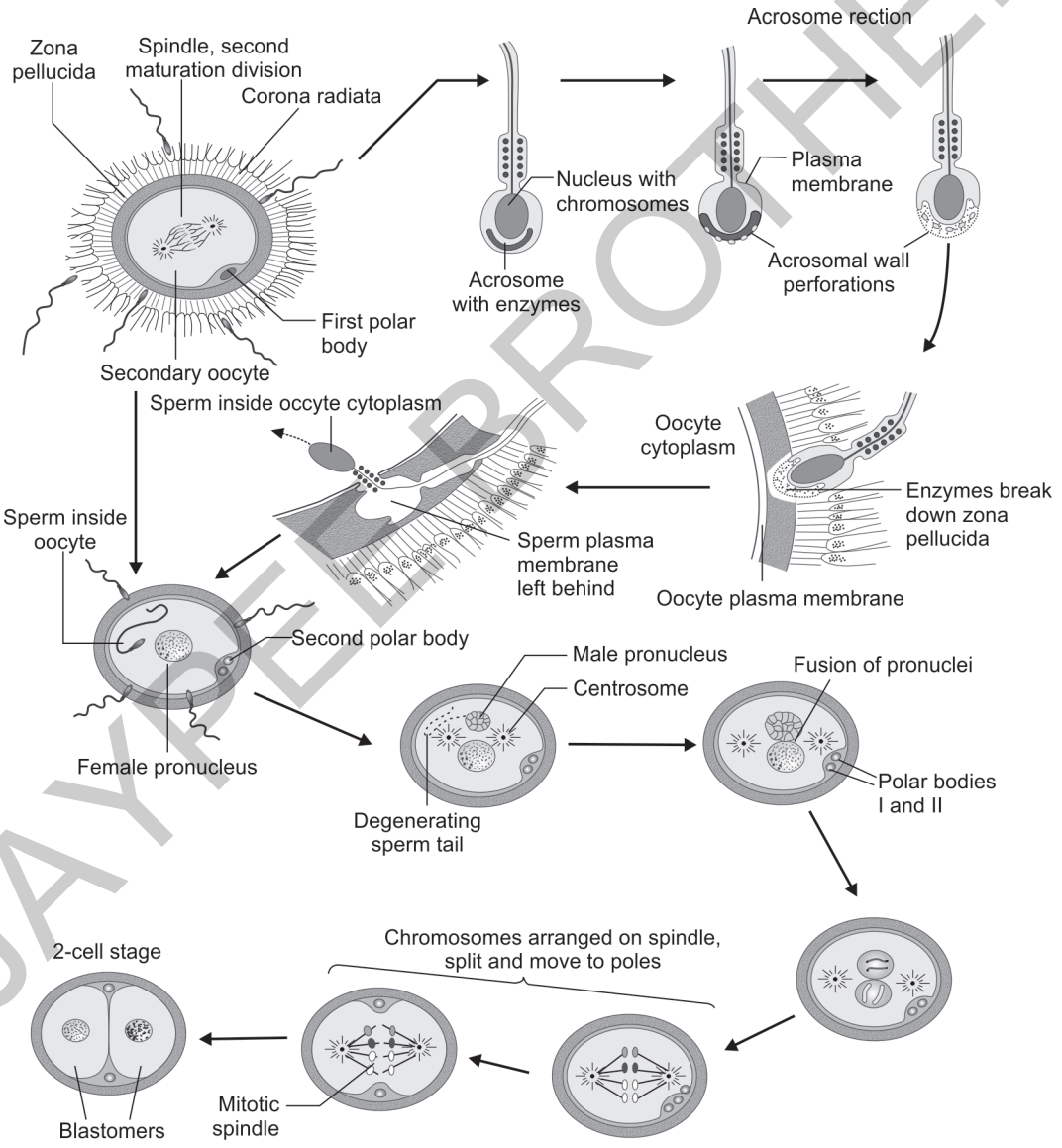

Fig. 2.10: Steps of fertilization.

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