بسم الله الرحمن الرحيم

GAMETOGENESIS

GAMETOGENESIS

Definition: The process of the formation of male & female gametes.

Site: in the gonads (testis and ovaries).

Types:

A- Spermatogenesis.

B- Oogenesis.

General characters [aim]:

Prepare sex cells for fertilization.

Reduction in number of chromosomes to half [diploid number ➔ haploid number]

Changes in the shape of the sex cells.

GAMETOGENESIS

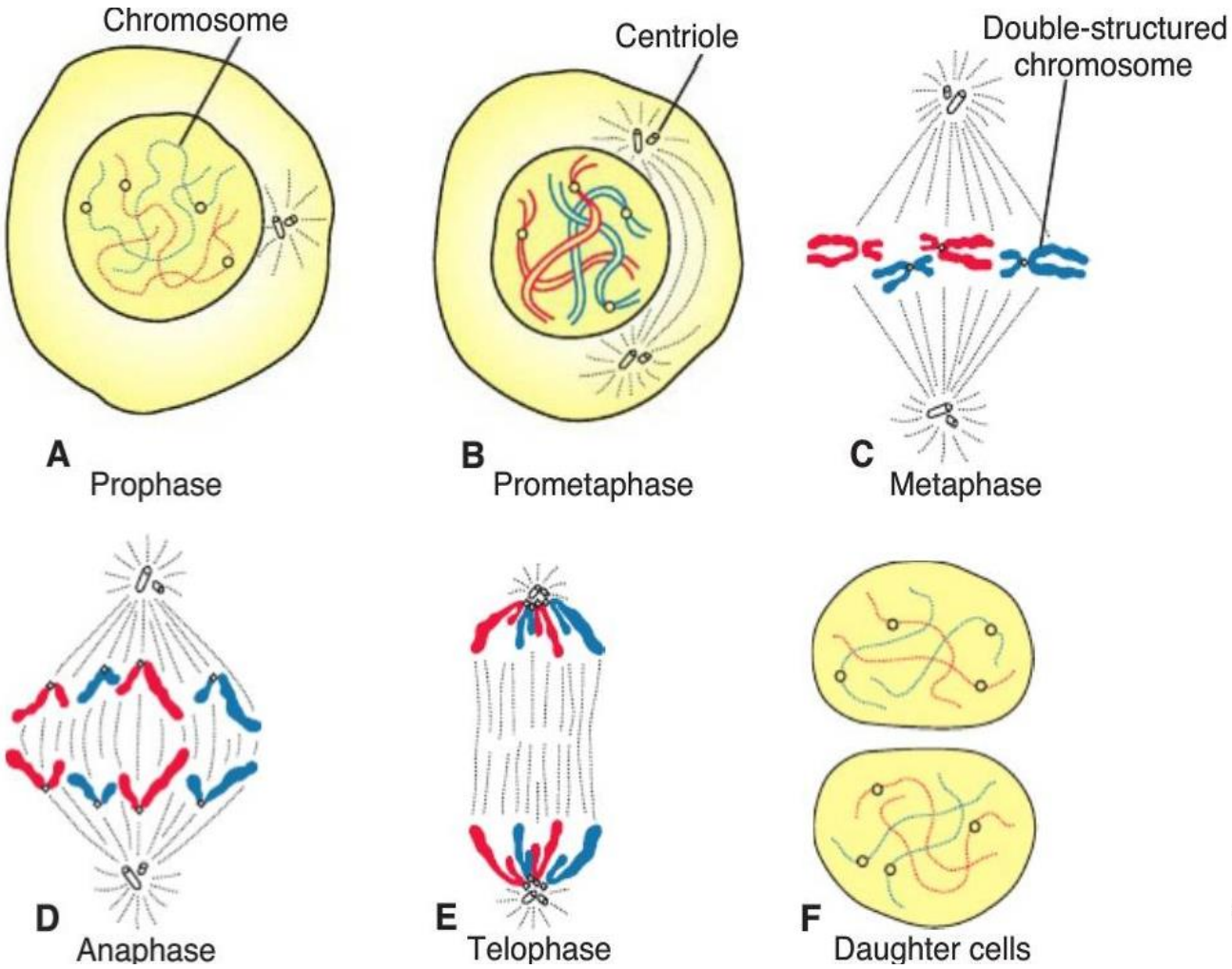
Terminologies

Oocyte (ovum /egg): refers to female germ or sex cells produced in the ovaries

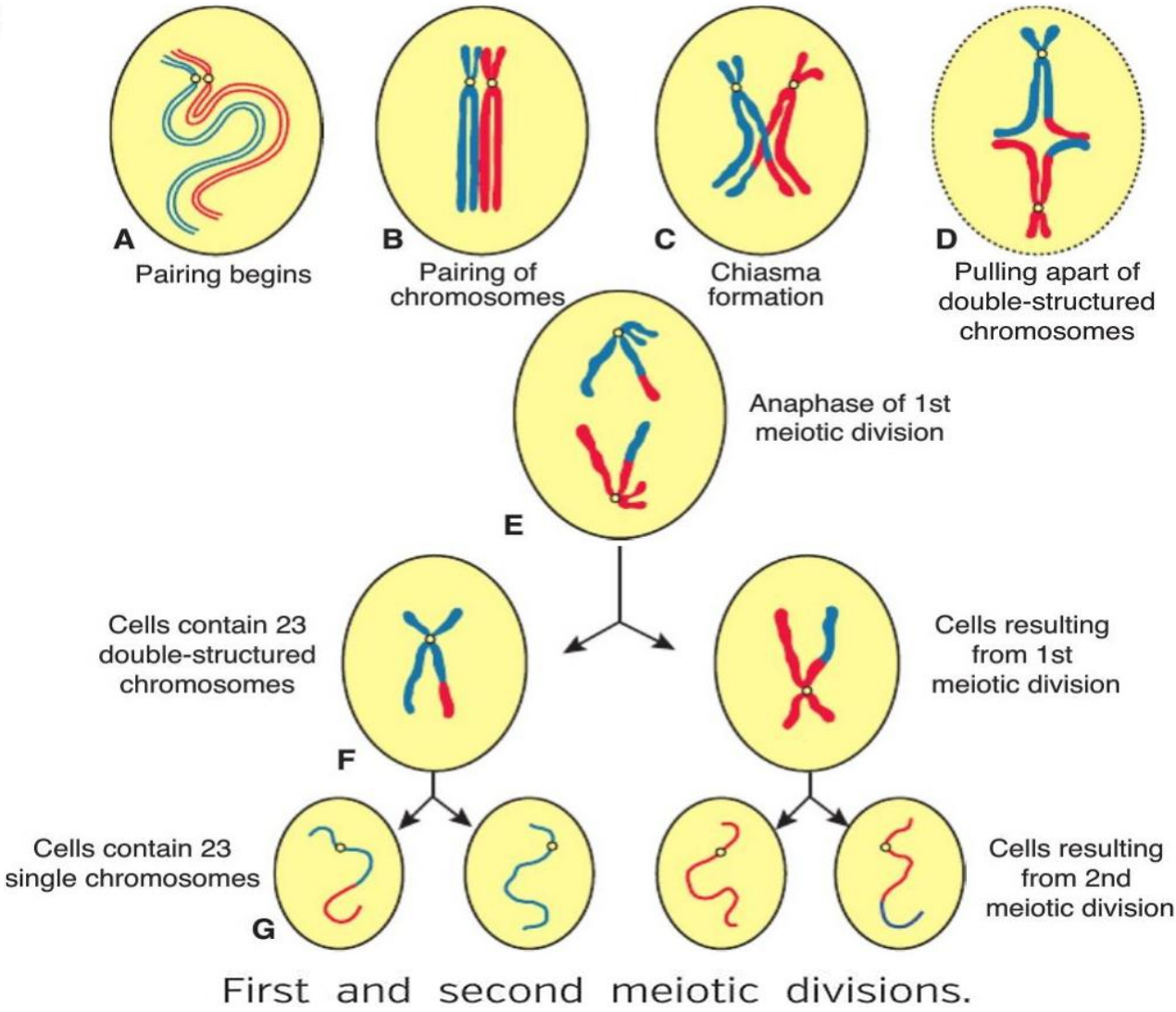
Sperm (spermatozoon): refers to male germ cell produced in the testes (testicles)

Zygote: results from the **union** of **an oocyte** and **a sperm** during **fertilization.**

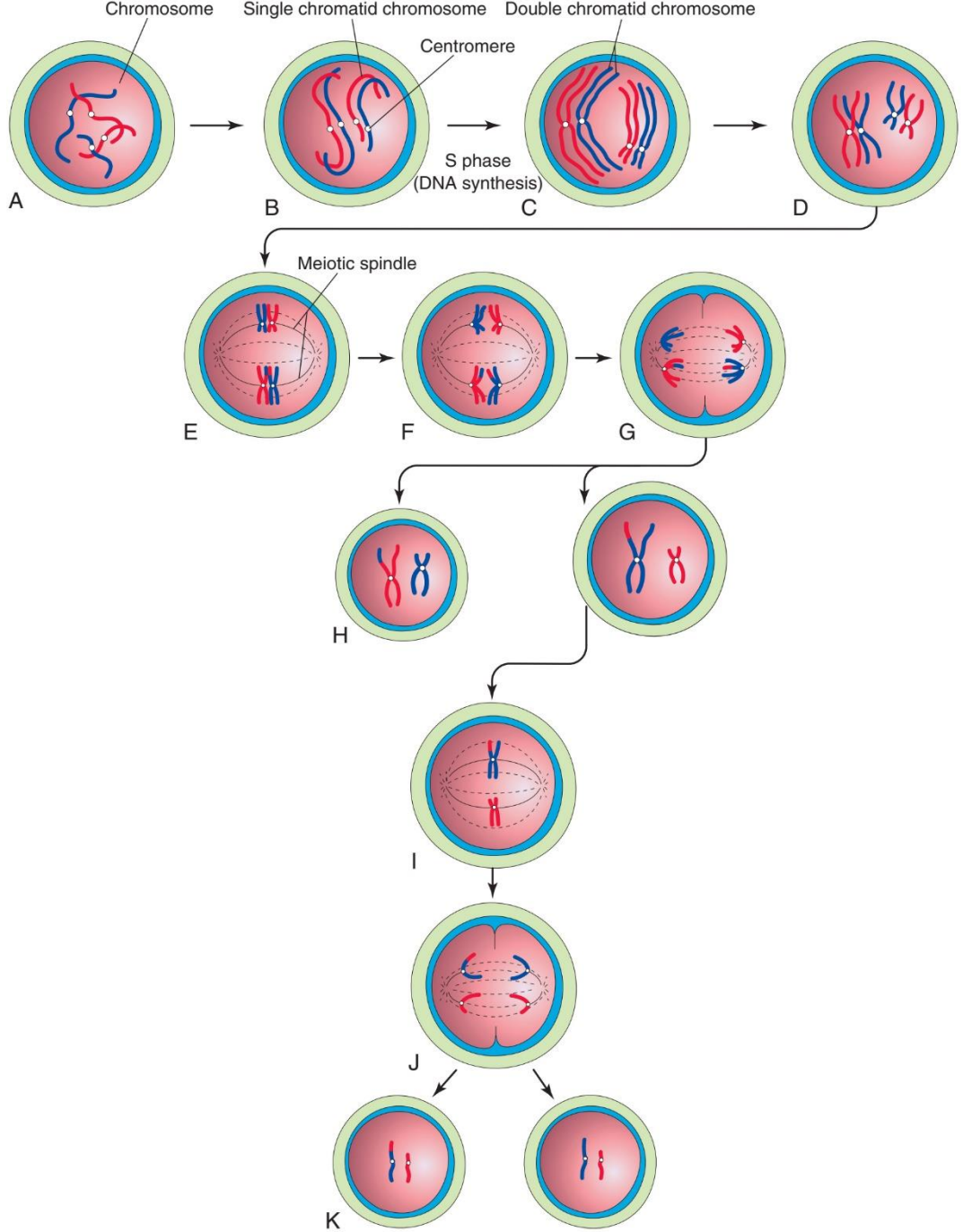
A zygote or embryo is the beginning of a new human being.



Mitotic division



First and second meiotic divisions.



Diagrammatic representation of meiosis.

A- Spermatogenesis

- **Definition:** transformation of primitive male germ cells (spermatogonia) into spermatozoa.
- **Site:** Seminiferous tubules of testis.
- **Onset:** begins from puberty (13 – 16 years) to old age.
- **Duration:** 64 days (2 months).
- **Steps:** 1.Spermatocytogenesis 2. Spermiogenesis.

A- SPERMATOGENESIS

1. Spermatocytogenesis

Stages:

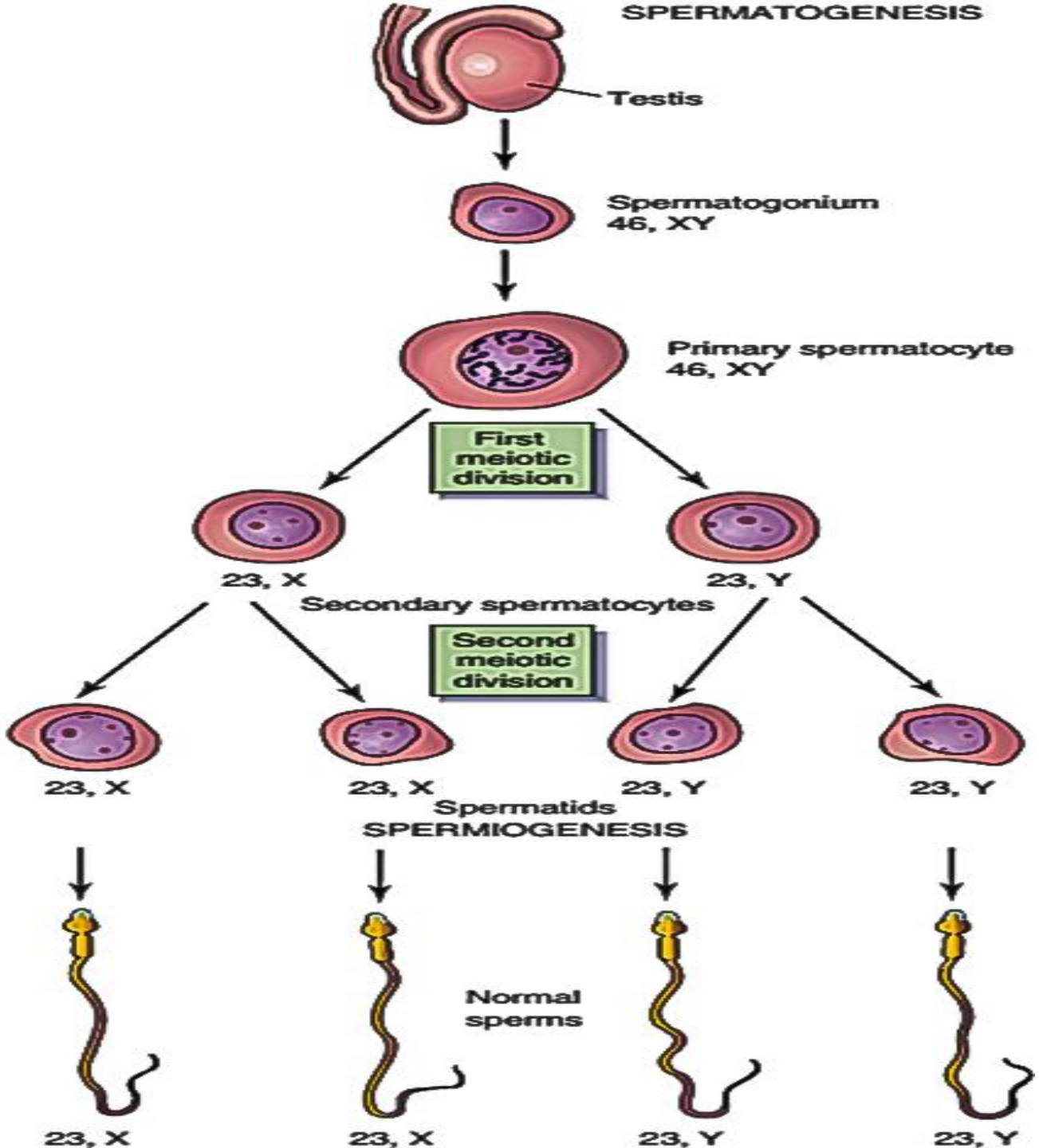
1. The spermatogonia (44-XY) divide by mitosis into 2 daughter spermatogonia (44-XY) which are 2 types:

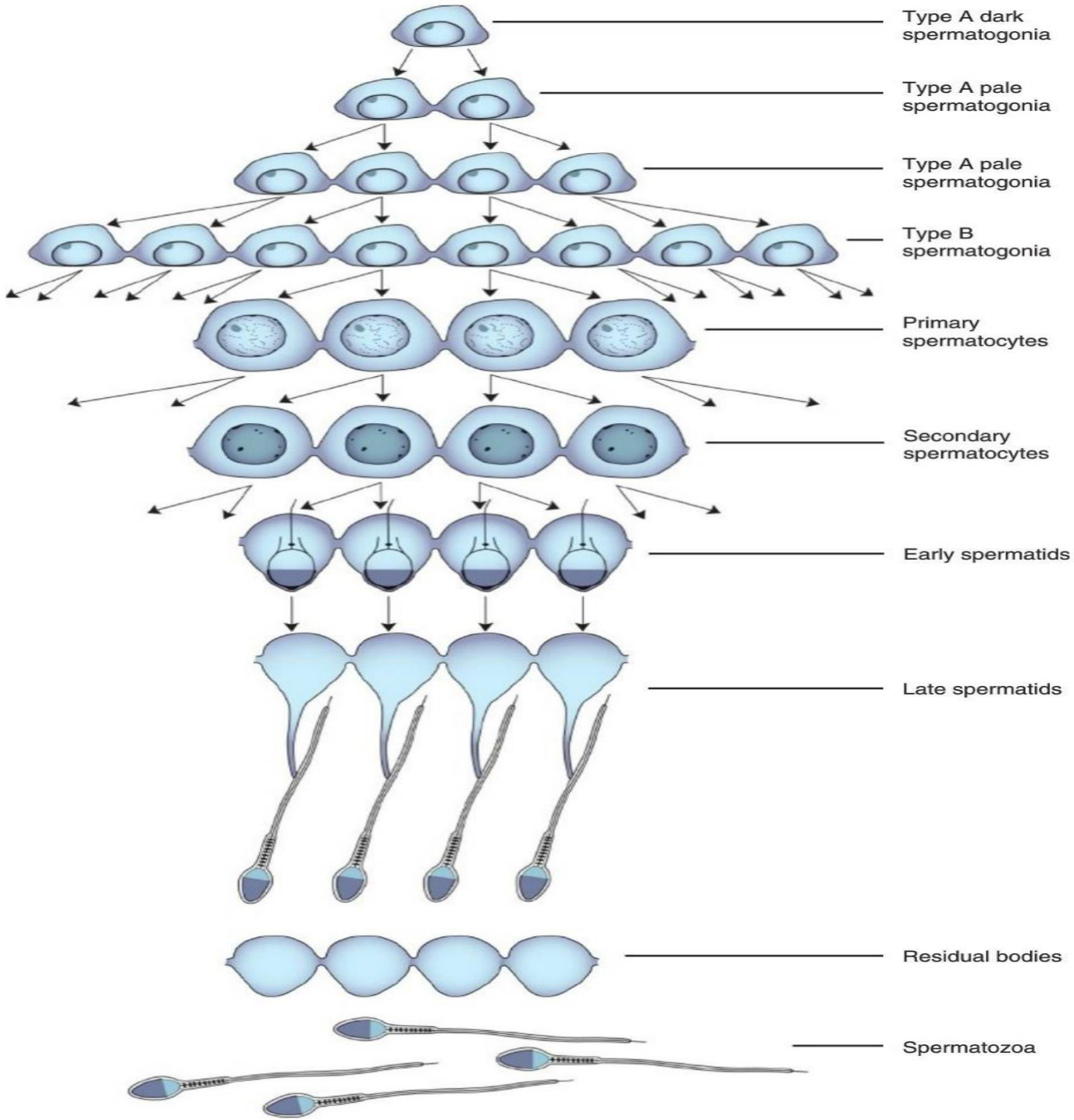
a. Type A: to renew itself.

b. Type B: Which grow & enlarge to form primary spermatocytes (4n DNA).

2. Each Primary spermatocyte divides by 1st meiotic division into spermatids (haploid DNA).

3. Each spermatid transform into a mature sperm by a process called spermiogenesis.


SPERMATOGENESIS
Testis
Spermatogonium
46, XY
Primary spermatocyte
46, XY
First meiotic division
23, X
23, Y
Secondary spermatocytes
Second meiotic division
23, X
23, X
23, Y
23, Y
Spermatids
SPERMIOGENESIS
Normal sperms
23, X
23, X
23, Y
23, Y

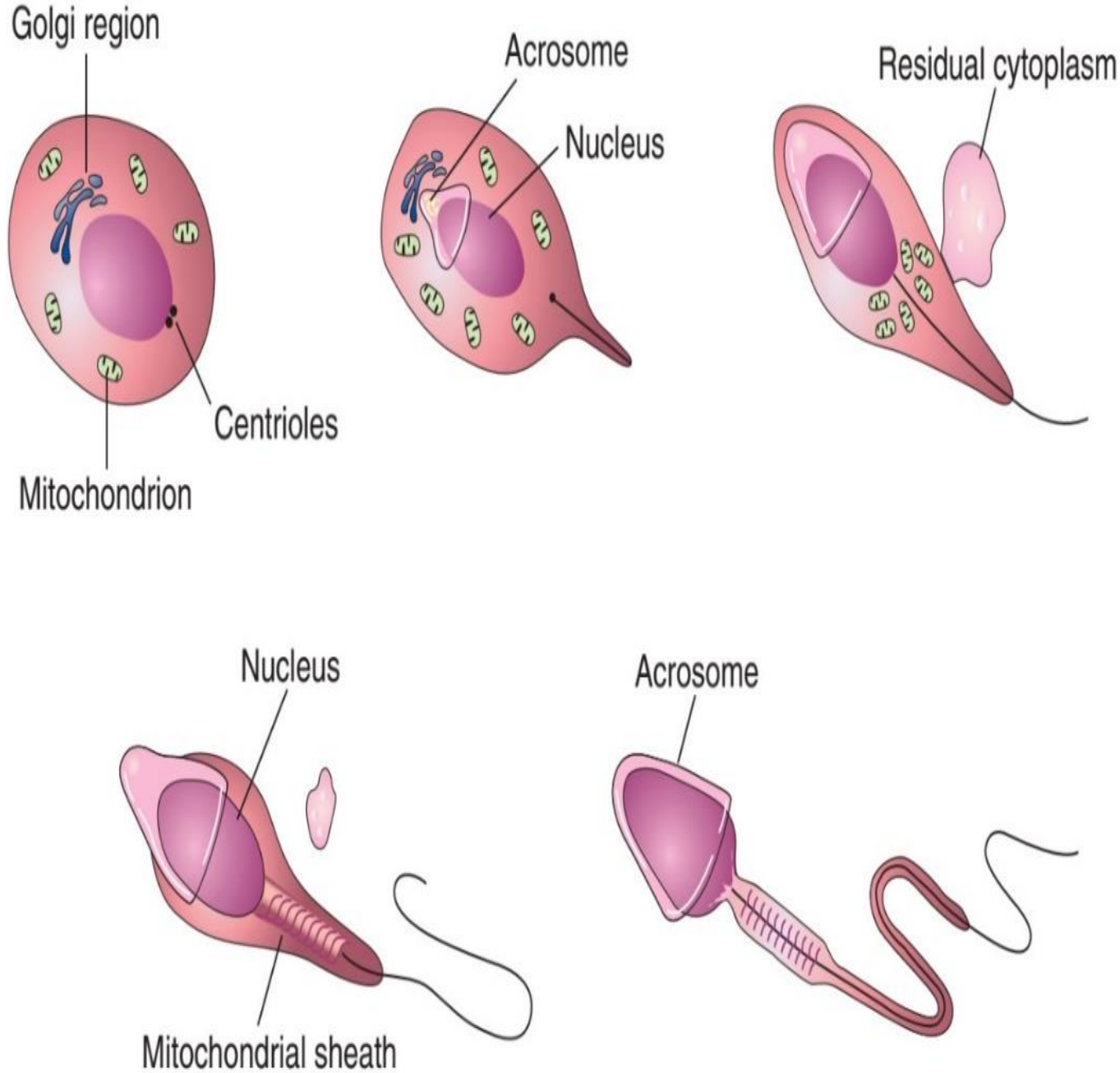

Type A dark spermatogonia
Type A pale spermatogonia
Type A pale spermatogonia
Type B spermatogonia
Primary spermatocytes
Secondary spermatocytes
Early spermatids
Late spermatids
Residual bodies
Spermatozoa

2. Spermiogenesis

Definition: morphological change of spermatids to mature sperms (spermatozoa).

Process:

1. **Nucleus:** Forms most of head of sperm.
2. **Golgi apparatus:** Forms acrosomal cap which covers anterior 2/3 of the nucleus.
3. **Centrioles**: directed towards the opposite side of the nucleus to form the tail of sperm.
4. **Mitochondria**: surround the 1st part of the tail to form Spiral sheath (concerned with energy production for movement.
5. **Cytoplasm:** most of the cytoplasm of the head is removed by the sertolli cells.



Illustrations of spermiogenesis, the last phase of spermatogenesis.

A- SPERMATOGENESIS

The mature sperm

- It consists of a head & a tail with a neck in between.

1. Head: contains the nucleus & its anterior 2/3 covered by the acrosome.

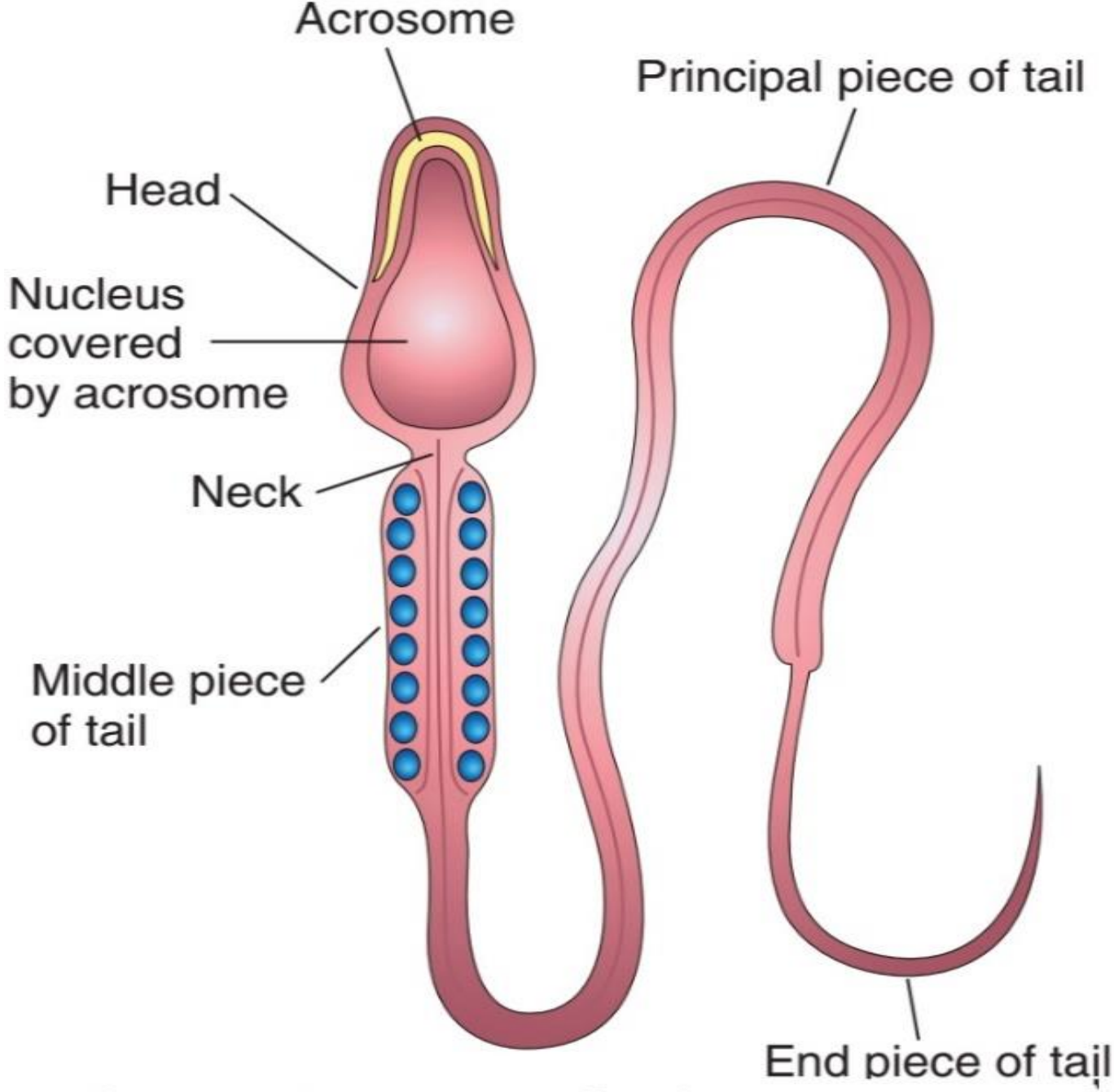
2. Neck: contain centeriols.

3. Tail: consists of 3 parts:

a. Middle piece: contains mitochondria which surround the 1st part of tail and it is concerned with energy production for movement.

b. Principal piece: longest part & provides motility of sperm.

c. End Piece.



The main parts of a human sperm

A- SPERMATOGENESIS

The seminal fluid

Formation:

1.Sperms: from testis.

2.Secretions: from the accessory sex glands (seminal vesicle, prostate & bulbo-urethral glands).

Characters:

- **Nature**: Thick, white and gelatinous fluid rich in glucose & fructose..
- **Volume**: 3-5 cc per ejaculation.
- **Odor**: Characteristic odor.
- **Reaction**: Alkaline.
- **Number of sperms**: 200-600 million per ejaculation.
- **Motility:** More than 80% of sperms are motile.
- **Shape:** normally Less than 10% abnormal in shape.

Functions:

1. Contain fructose for sperm nutrition.
2. Contain prostaglandins for sperm motility & transport.
3. Alkaline to neutralize the vaginal acidity.

A- SPERMATOGENESIS

Anomalies:

1.Number:

- Azospermia: Complete absence of the sperms.
- Oligospermia: the number is less than 20 million per ejaculation.

2.Motility:

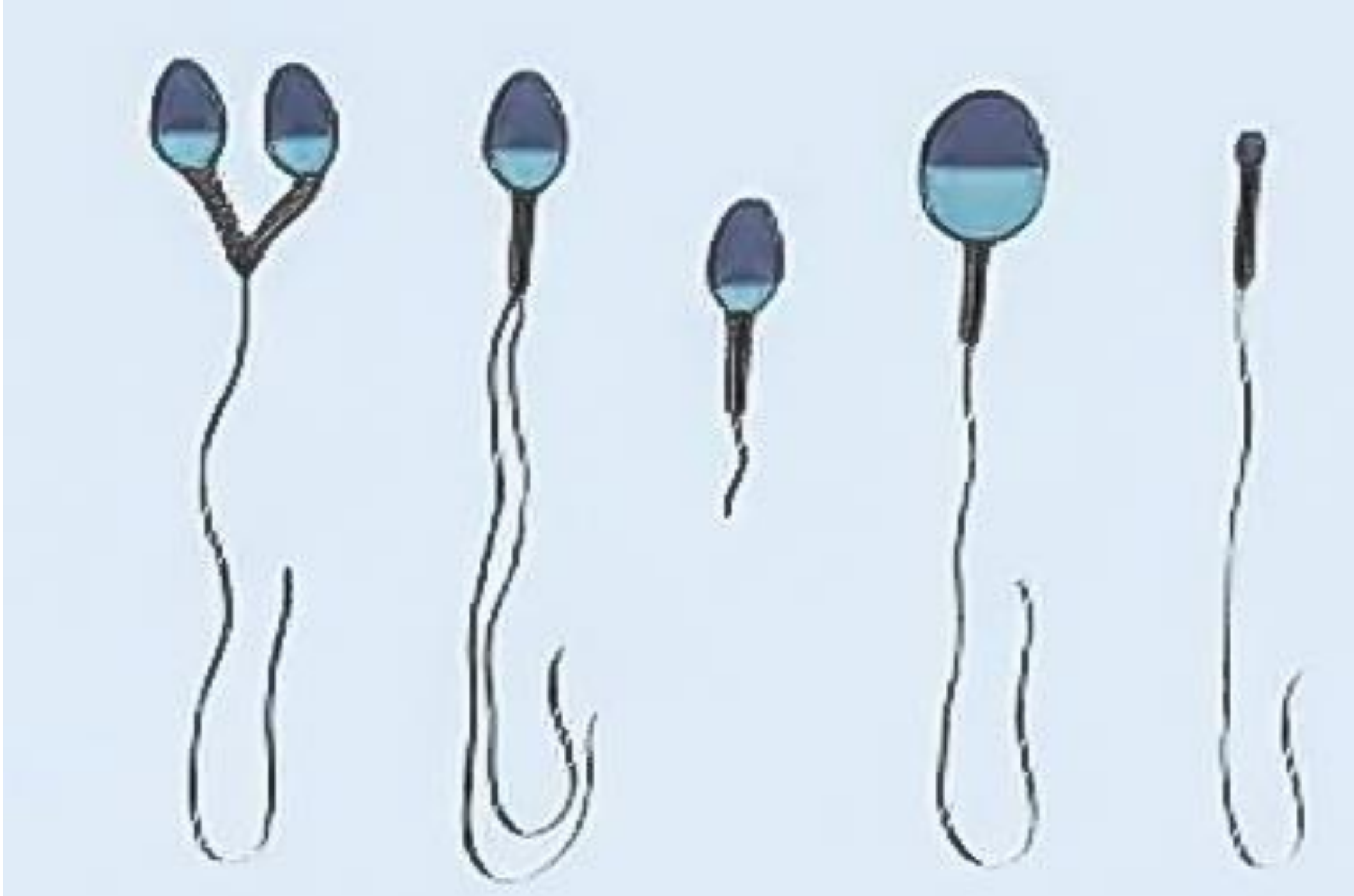
- Immotile
- Necrospermia: presence of dead sperms.

3.Shape:

- Dwarf sperms: very small sperms.
- Giant Sperms: very big sperms.
- Sperms has 2 heads or 2 tails.

Fate:

- Only about 400 sperms reach the ampulla of the uterine tube after 5 minutes of their deposition.
- Their fertilization power lasts only for 24 hours.
- Only 1 sperm is allowed to enter the ovum.



B. OOGENESIS

- **Definition:** Transformation of the primitive female germ cells (oogonium) into mature ovum.
- **Site:** Cortex of the ovary.
- **Onset:** From intra-uterine life to menopause.
- **Process:**

1. During intrauterine life (Prenatal maturation of oocytes):

- Oogonia increase in number by mitosis daughter oogonia (44-XX).
- Each daughter oogonium enlarges to form 1ry oocytes (44-XX-4n).
- **The 1ry oocyte** begins 1st meiotic division **before birth** but remains in the resting prophase **till puberty**.

B. OOGENESIS

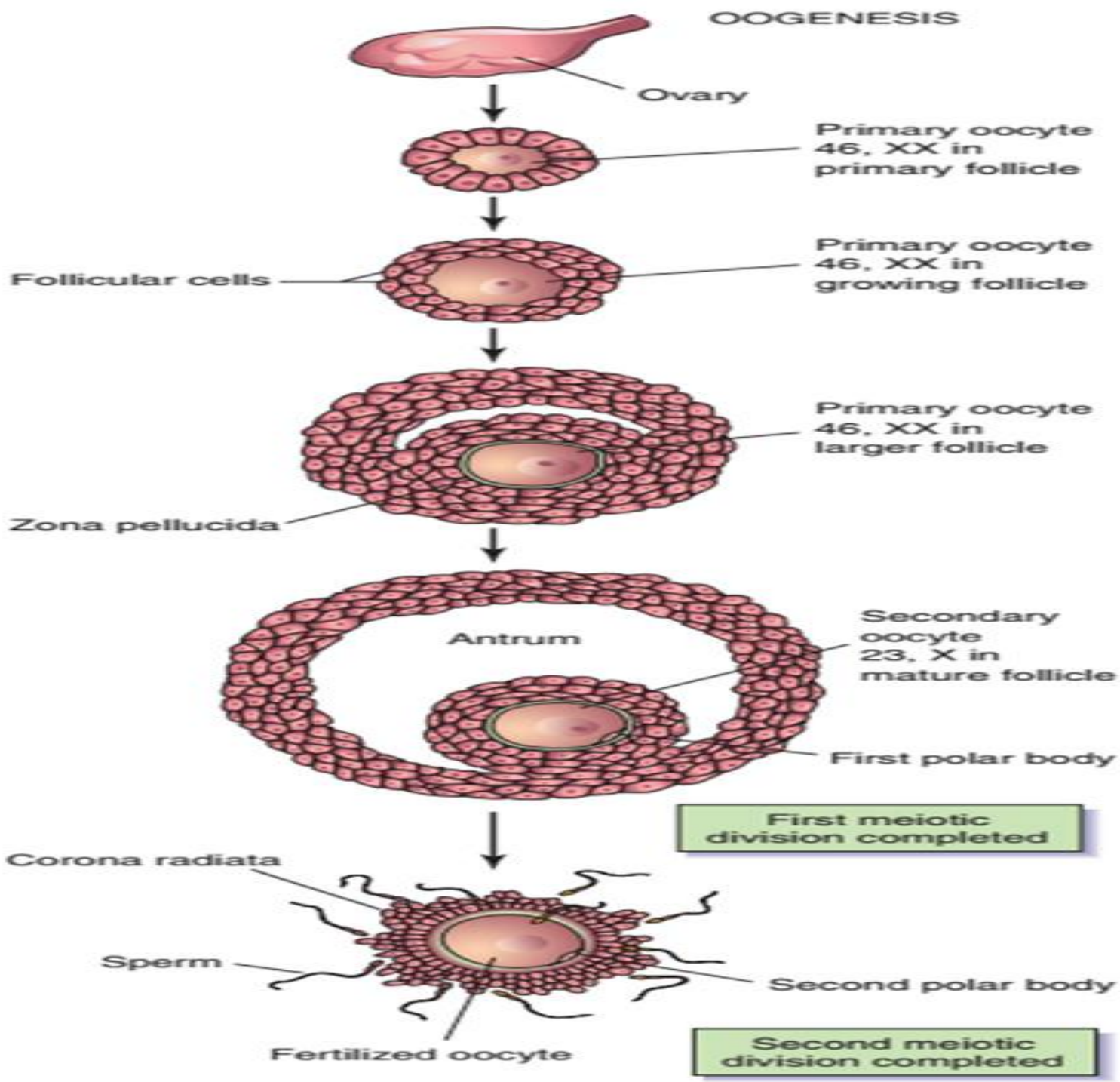
2. Before ovulation (Postnatal maturation of oocytes):

- **At puberty:** the 1ry oocytes begins to complete 1st meiotic division every month and gives rise to 2ry oocyte and the 1st polar body.
- **At ovulation:** the 2ry oocyte and the 1st polar body begin the 2nd meiotic division, but the division is arrested in metaphase till fertilization.

3. After ovulation:

a. If fertilization occurs, the 2nd meiotic division is completed to give 2 cells: mature ovum & 2nd polar body, the 1st polar body also divides into two 2nd polar bodies.

b. If fertilization does not occur, the 2ry oocyte degenerates after 24 hours.


OOGENESIS
Ovary
Primary oocyte
46, XX in
primary follicle
Follicular cells
Primary oocyte
46, XX in
growing follicle
Primary oocyte
46, XX in
larger follicle
Zona pellucida
Antrum
Secondary
oocyte
23, X in
mature follicle
First polar body
First meiotic
division completed
Corona radiata
Sperm
Second polar body
Fertilized oocyte
Second meiotic
division completed

B. OOGENESIS

N.B: The number of oocyte in females;

1. 2 million 1ry oocytes in the ovaries of the newborn females.

2. 40000 1ry oocytes during adolescence.

3. 480 become 2ry oocytes used by ovulation during reproductive life.

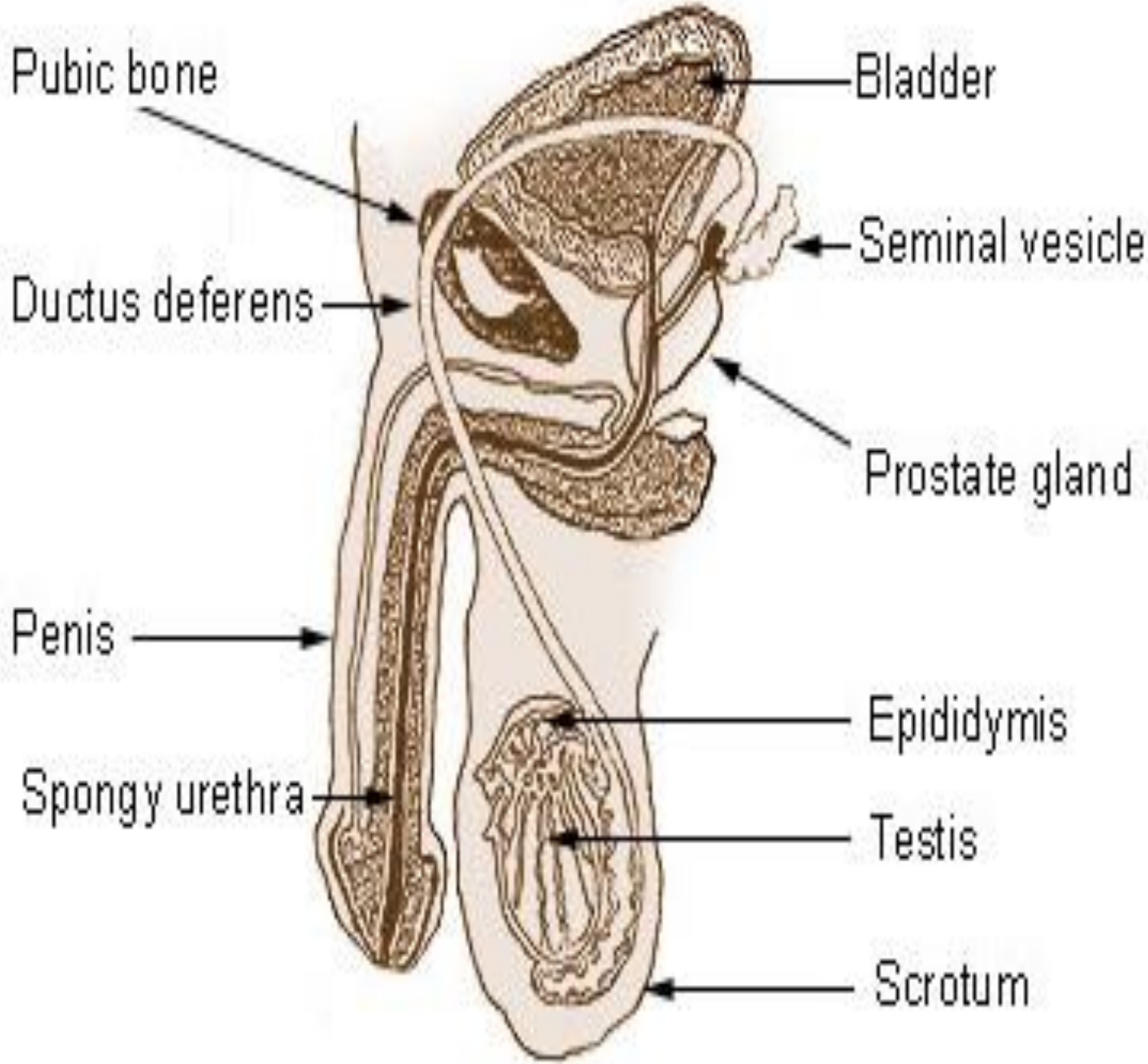
Sperm transport

1.In male:

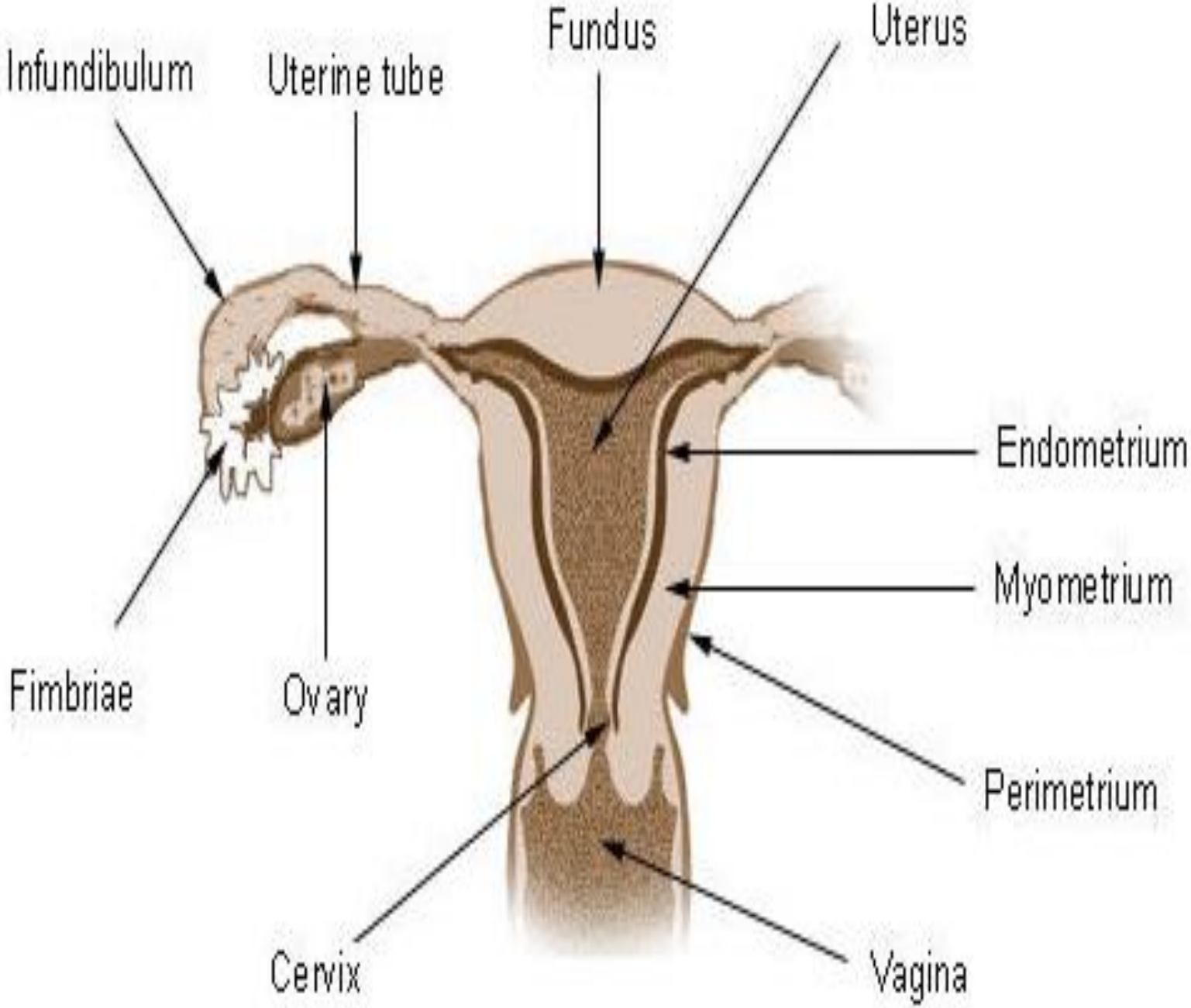
- From the **epididymis** to **urethra** through **Vas deference**.
- As the sperms pass through the male ducts secretions from the accessory sex glands are added to it to form the seminal fluid.

2.In female:

- During sexual intercourse from **200 – 600 million** sperms deposited around **Posterior fornix of vagina**.
- The sperms pass through **the cervical canal** by the movement of its tail to reach **uterus**.
- Then passes through uterus to reach **uterine tube**.


Pubic bone
Bladder
Seminal vesicle
Ductus deferens
Prostate gland
Penis
Epididymis
Spongy urethra
Testis
Scrotum

Uterus and Uterine tubes



COMPARISON

Male gametes	Female gametes
The sperm is highly motile.	The mature oocyte is immotile.
The sperm have a little cytoplasm.	The mature oocyte is a massive cell.
The cytoplasm of the sperm contains no yolk granules.	The cytoplasm of the mature oocyte contains yolk granules which provide nutrition to the dividing zygote during the first week after fertilization.
There are two types of normal sperm: 22 + X and 22 + Y.	There is one type of ovum: 22 + X.
Production of 1ry spematocytes after puberty	No primary oocytes after birth

FEMALE REPRODUCTIVE CYCLES

CYCLIC CHANGES

A. Ovarian Cycle

- **Definition**: cyclic changes that occurs in the ovaries.
- **Time**: Begins at puberty (8-14 year) and ends at menopause (45-55 year), and stops during pregnancy.
- **Duration**: 28 days (lunar month).
- **Cause**: FSH and LH.
- **Phases**: three phases:

1) Follicular phase (preovulatory phase).

2) Ovulation.

3) Luteal phase (postovulatory phase).

1) Follicular Phase:

a) Primordial follicles: Time: from 1st day to day 13

1ry oocyte surrounded by a single layer of follicular cells which are at first flat cells (before birth), but later they become cuboidal (during puberty).

b) Growing follicle: The primary follicle gradually increases in size due to:

(a) **Ovum**: increase in size.

(b) **Two membranes** are added by the follicular cells:

- Zona pellucida: around the ovum (amorphus, acellular glycoprotein material).
- Basement membrane: around the follicular cells

CYCLIC CHANGES

(c) Follicular cells: proliferate and become many layers (called granuloza cells). They secrete estrogen.

(d) The follicular cells: secret fluid in the inter follicular spaces. These spaces enlarge and fuse together to form one large cavity called the follicular cavity filled with the follicular fluid.

(e) Theca: arrangement of connective tissue around the growing follicle and differentiate into two layers:

a. Theca interna: internal vascular layer.

b. Theca externa: external fibrous layer.

 When all these changes occur, the growing follicle called mature Graafian follicle.

c) Mature Graafian Follicle:

- **Site**: in the cortex of the ovary.
- **Time**: at 14th day (midcycle).
- **Shape**: rounded.
- **Size**: 2 cm in diameter.
- **Function:** Secrets estrogen and protects oocyte.
- **Fate:** The Graafian follicle ruptures and gives 2ry oocyte and corpus luteum.
- **Structure**: from outside inwards:

(a) Theca externa.

(b) Theca interna.

CYCLIC CHANGES

(c) Granulosa (follicular) cells: many layers of follicular cells surrounding follicular cavity and classified into:

1) Corona radiate: few layers of cells surrounding the ovum.
2) Cumulus oophorus: follicular cells connecting corona radiate with granulosa cells.
3) Granulosa (follicular) cells: all around the follicle.

(d) The follicular cavity: filled with the follicular fluid, and contains estrogen.

(e) zona pellucida: becomes more thick.

(f) Ovum: increase in size (500 micron) and immediately before ovulation it completed its 1st meiotic division and becomes 2ry oocyte:

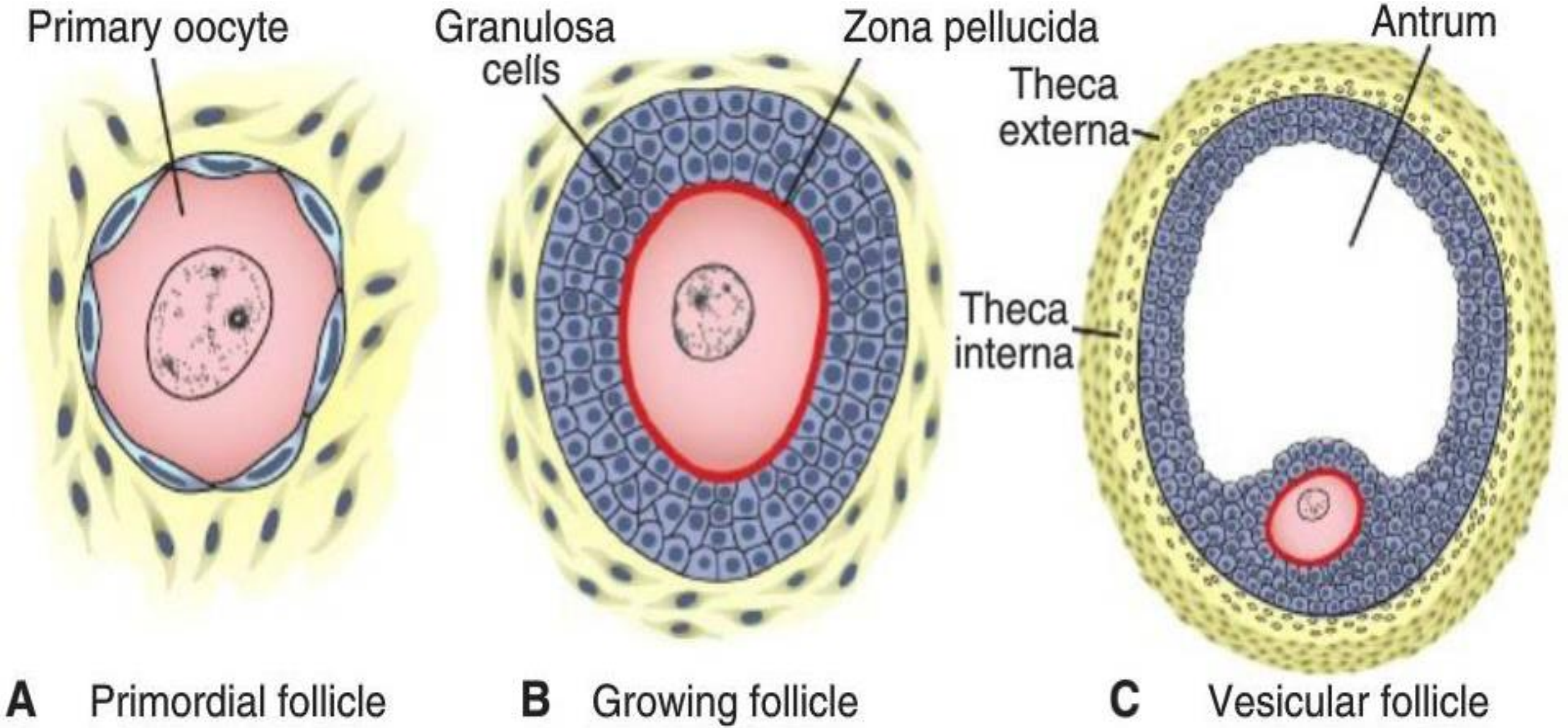
2)Ovulation:

- **Definition**: rupture of the mature Graafian follicle and liberation of the ovum which surrounded by the zona pellucida and corona radiata.

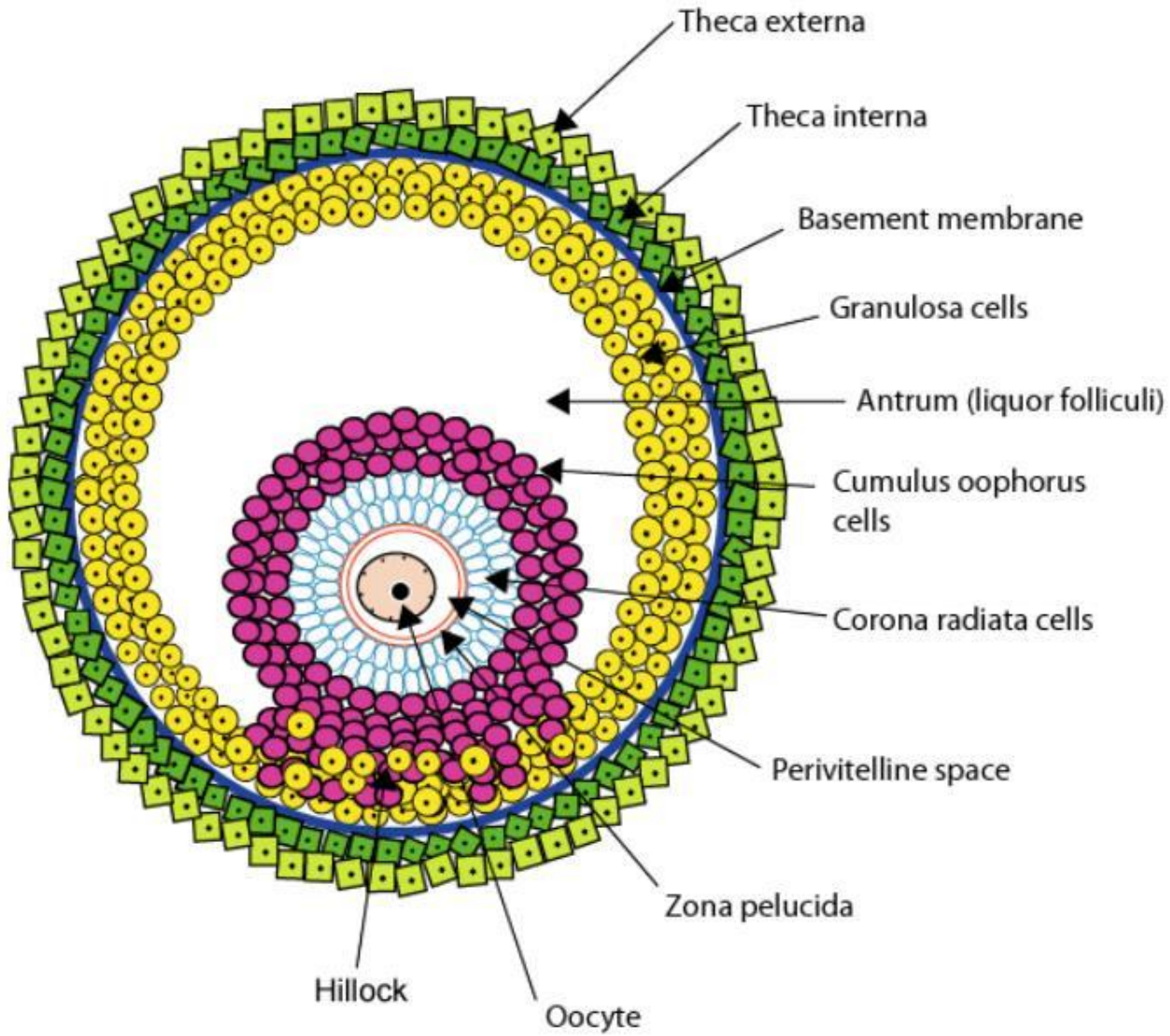
- **Fate**: it enters the uterine tube where it is either fertilized or discharged from the uterus during the menstrual period.

- **Time**: midcycle (14 days in an average 28-day menstrual cycle).

CYCLIC CHANGES



Anatomy of a Graafian Follicle



CYCLIC CHANGES

- **Causes**:

1. **FSH and LH hormones**.
2. **Prostaglandins:** produces contraction of the smooth muscles in the theca externa.
3. **The high osmotic pressure** of the fluid inside follicular cavity due to high levels of LH.

3) Luteal phase:

- After ovulation, the wall of the Graafian follicle collapse.
- The follicular cavity becomes filled with **blood** and forms the **corpus haemorrhagicum**.
- Three days later, the bleeding stop and the granulosa cells enlarge and become distended with the **yellow pigment** (**lipochrome**) and transformed into a **yellow body**, known as the **corpus luteum.**
- **The corpus luteum**: secretes **progesterone** from theca interna cells and secretes estrogen by follicular cells.
- It lives for **9 days** then **degenerate** if pregnancy doesn't occur.

CYCLIC CHANGES

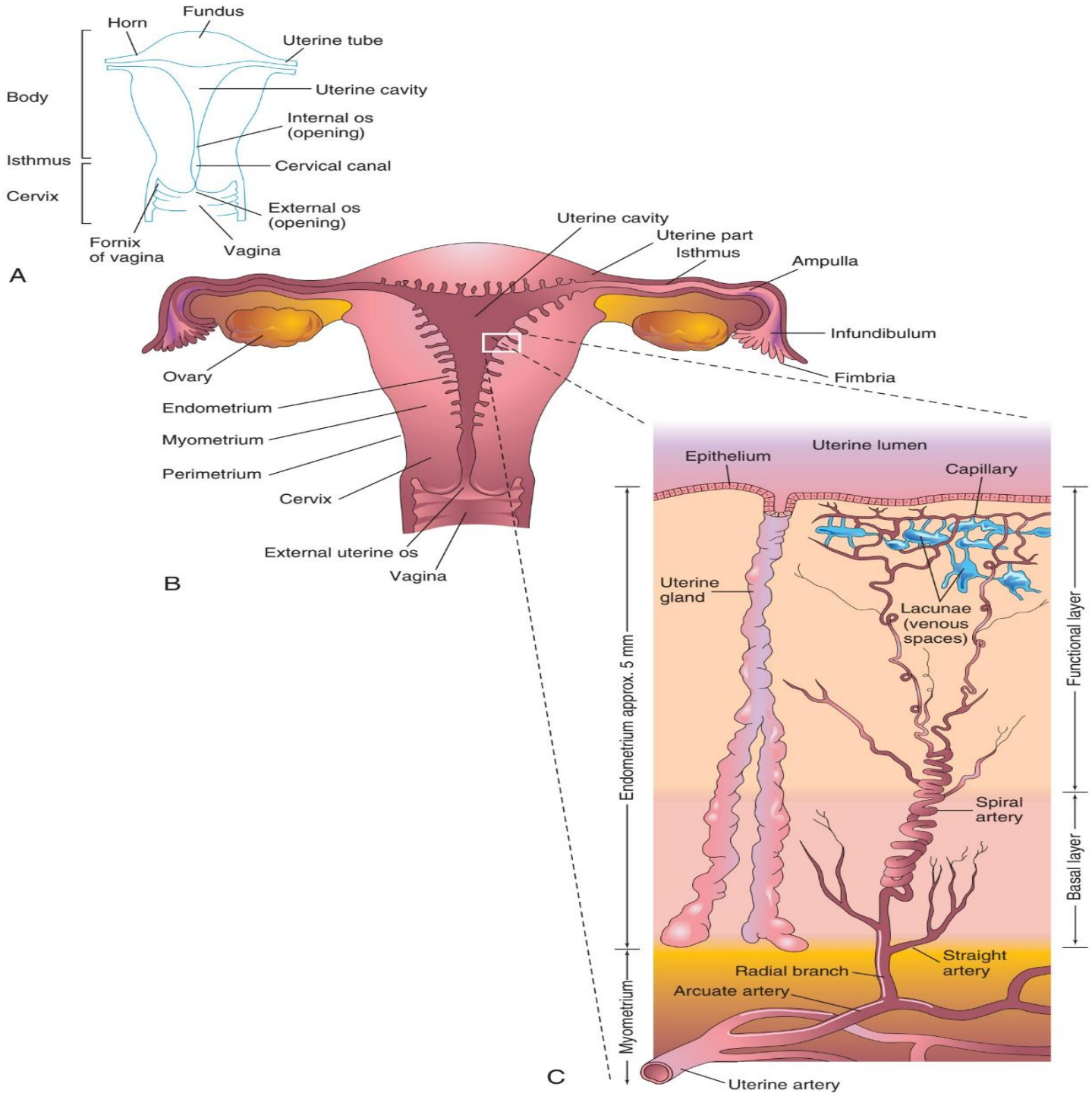
Fate of corpus luteum:

- If fertilization occur: the corpus luteum enlarges and continues to secrete progesterone till 4th month of pregnancy and called corpus luteum of pregnancy.
- If fertilization doesn't occur: the corpus luteum begins to degenerate about 10 to 12 days after ovulation and transformed into white fibrous tissue in the ovary called the corpus albicans.

B. Menstrual (Uterine) cycle

- **Definition**: Cyclic and structural changes in the endometrium of the uterus every 28 days (Lunar month).
- **Onset**: from puberty till menopause.
- **Cause**: estrogen and progesterone.
- **Phases**: three main phases.

1) **Menstrual (bleeding) phase.**
2) **Proliferative (estrogenic) phase.**
3) **Secretory (luteal, progestronic) phase.**


Horn
Fundus
Uterine tube
Body
Uterine cavity
Internal os (opening)
Isthmus
Cervical canal
Cervix
External os (opening)
Fornix of vagina
Vagina
A
Uterine cavity
Uterine part
Isthmus
Ampulla
Infundibulum
Fimbria
Ovary
Endometrium
Myometrium
Perimetrium
Cervix
External uterine os
Vagina
B
Epithelium
Uterine lumen
Capillary
Uterine gland
Lacunae (venous spaces)
Spiral artery
Straight artery
Radial branch
Arcuate artery
Endometrium approx. 5 mm
Functional layer
Basal layer
Myometrium
Uterine artery
C

CYCLIC CHANGES

1) Menstrual (bleeding) phase:

- **Duration**: usually lasts 4 to 5 days

N.B.: The 1st day of menstruation is the beginning of the cycle.

- **Cause**:
  - Degeneration of the corpus luteum causes sudden failing of progesterone level.

2) Proliferative (estrogenic) phase:

- **Duration**: about 9 days (from the end of the menstrual phase till 14th day of the cycle).

N.B: proliferative phase coincides with the growth of ovarian follicles.

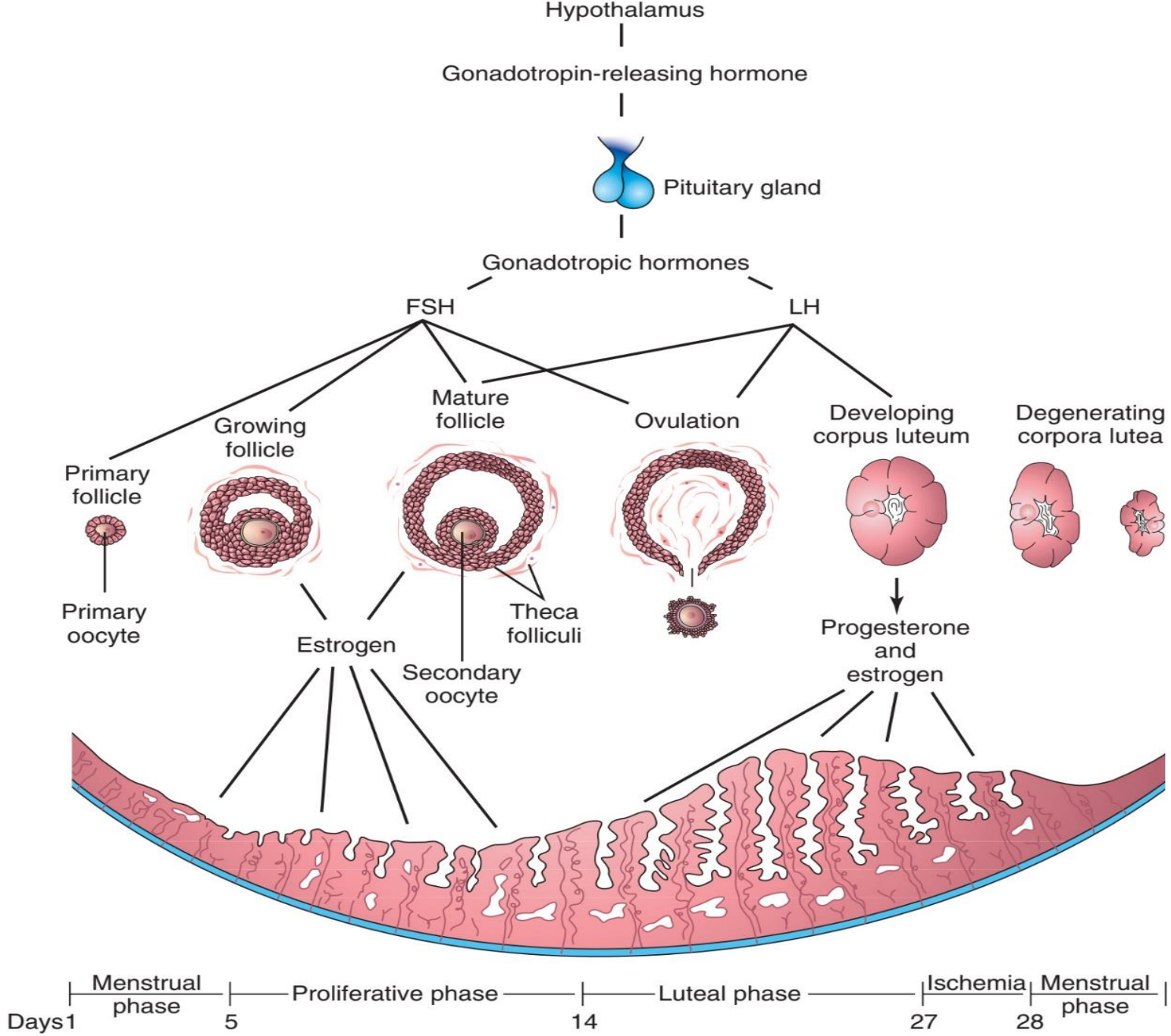
- **Cause**: estrogen secreted by growing follicles.

3) Secretory (luteal, progestronic) phase:

- **Duration**: about 14 days Extends from the time of ovulation.

N.B: It coincides with the formation and growth of the corpus luteum.

- **Cause**: progesterone and estrogen hormones produced by corpus luteum.



Interrelations of the hypothalamus of the brain, pituitary gland, ovaries, and endometrium.

CYCLIC CHANGES

- **Characters of menstrual phase:**

- **Menstrual blood:** is the bleeding from vagina.
- **Amount:** 50-60 c.c.
- **Time**: from 3 to 7 days
- **Contents:**

  i. **Unclotted blood.**

  ii. **2ry oocyte and its surrounding (zona pelllucida and corona radiate).**

  iii. **Superficial layer of endometrium (stratum compactum and stratum spongiosum)**

Thank you