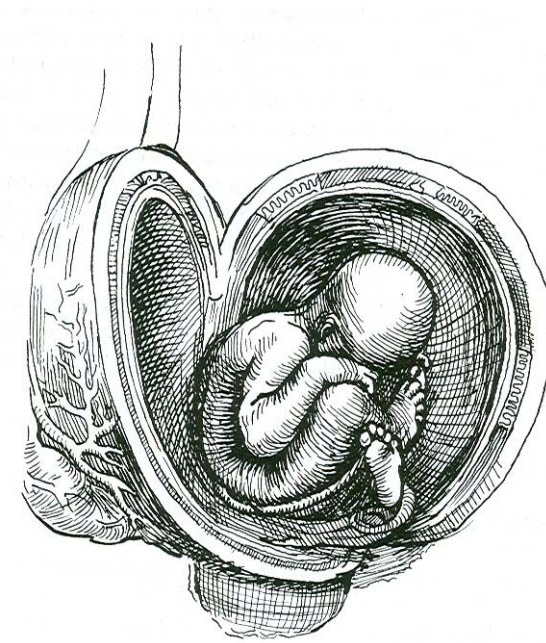


GENERAL EMBRYOLOGY

- An intricate and miraculous process by which a single cell gives rise to a highly developed multicellular human being.
- A continuous process that begins when an oocyte (ovum) is fertilized by a sperm to form a zygote which differentiates in to definitive organ system and thereafter in to their early functional stage.



- Development, growth and differentiation continues after. So the total life span of a human is divided in to phases.
- Prenatal (I.U.) before birth (total 280 days)
- Birth
- Postnatal (E.U.) after birth which can be further divided in to:
 - Infancy
 - Childhood
 - Puberty
 - Adolescence
 - Adulthood

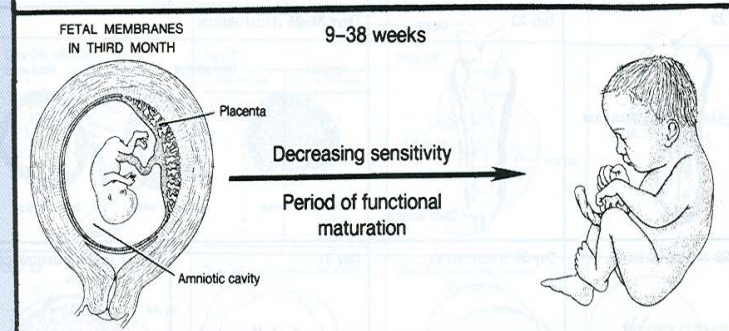
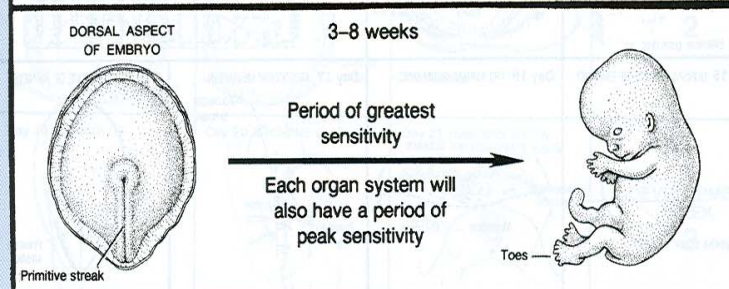
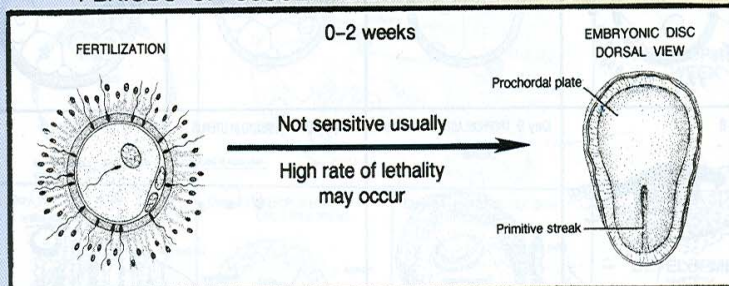
Prenatal life comprises of three periods:

1. Pre-embryonic: 0-2 weeks
2. Embryonic: 3-8 weeks (period of organogenesis)
3. Fetal: 9 weeks to birth

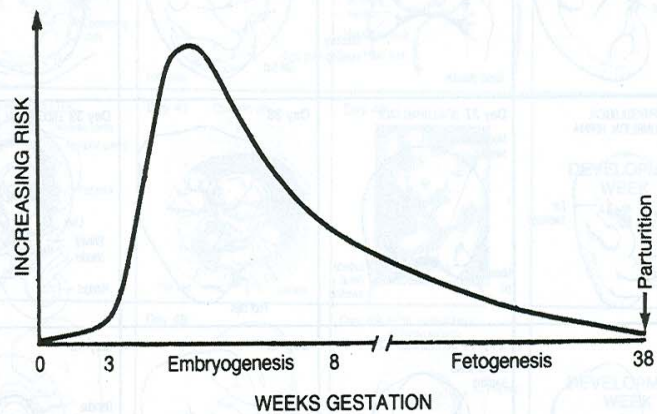
First eight weeks are further divided into 23 stages

Stage one (day one) corresponds to fertilization

PERIODS OF SUSCEPTIBILITY TO TERATOGENESIS



RISK OF MALFORMATIONS OCCURRING



Significance

- Knowledge of development of different organs, tissues and systems. It also provides a basis for understanding the functional activity of the organism.
- Provides explanation for various relationships, position, asymmetry, distant blood supply or nerve supply to a structure which can not otherwise be explained on the basis of adult anatomy.
- To correlate the analogous development of various other organisms such as vertebrates, other mammals so as to ensure whether results drawn from other species can be applicable to human beings.

Significance (contd.)

- Helps to understand the cause of variations.
- New techniques for prenatal diagnosis and treatments. Essential for creating health care strategies for better reproductive outcomes.
- Mechanisms to prevent birth defects – a leading cause of infant mortality.
- Treating infertility or spontaneous abortions.

Subdivisions

- Ontogeny**- is the total life period of an organism.
- Developmental anatomy**- involves changes in cells, tissues, organs. Growth, differentiation and metabolism all occur side by side in the developing embryo.
- Comparative embryology**- comparison and correlation with the development occurring in other animals.
“ Ontogeny repeats phylogeny”
- Experimental embryology**- production of virtually real models of embryos in the laboratories and observation of process of genesis going on.
- Teratology**- deals with abnormal development resulting in congenital defects.
- Applied embryology**- to apply knowledge received by comparative and experimental embryology to the development of human beings.
- Genetics**- to evaluate the role of heredity and environment in shaping up the new born.

Common terms used in embryology

- Oocyte (Ovum)- a mature secondary oocyte ready for fertilization.
- Sperm or spermatozoa- male gamete
- Zygote- diploid, fertilized cell which has the potential to produce an embryo.
- Cleavage- continuous, rapid mitotic cell divisions occurring in zygote just after fertilization.
- Morula- as a result of cleavage, zygote appears like a mulberry bush consisting of small tightly packed cells.
- Conceptus- the developing embryo or fetus along with its associated membranes.
- Embryo- first eight weeks of developing human when the primordia of almost all the organs and system have appeared.

Common terms used in embryology

- Fetus-fetal period is from 9th week till birth which is marked by differentiation, growth of tissues and organs and subsequent weight gain.
- Primordium- the first sign of the development of a new organ/region. With more differentiation and growth, the structure gradually changes to primary, secondary or definitive etc.
- CR Length and CH Length- during early development of embryo the size of the growing embryo can be measured from the vertex of the cranium to the rump (CR length) or from the crown to the heels (CH length).

Gametogenesis

- Process of formation and development of specialized generative cells – gamete
- Prepares sex cells for fertilization

Meiosis

- Produces haploid gametes
- Allows random assortment of maternal and paternal chromosomes between the gametes
- Crossing over of chromosome segments- produces a recombination of genetic material

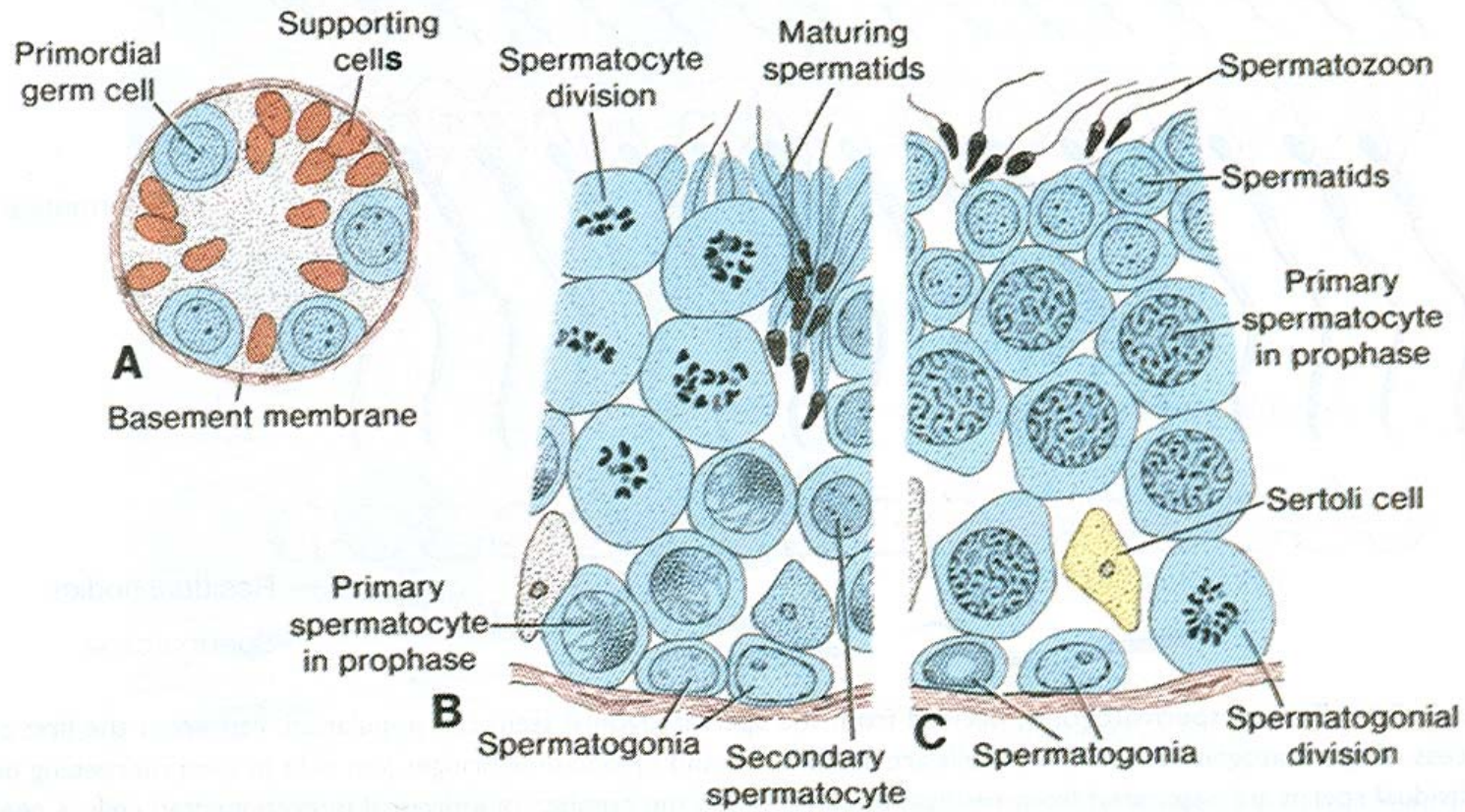
Nondisjunction- chromosomally abnormal gametes

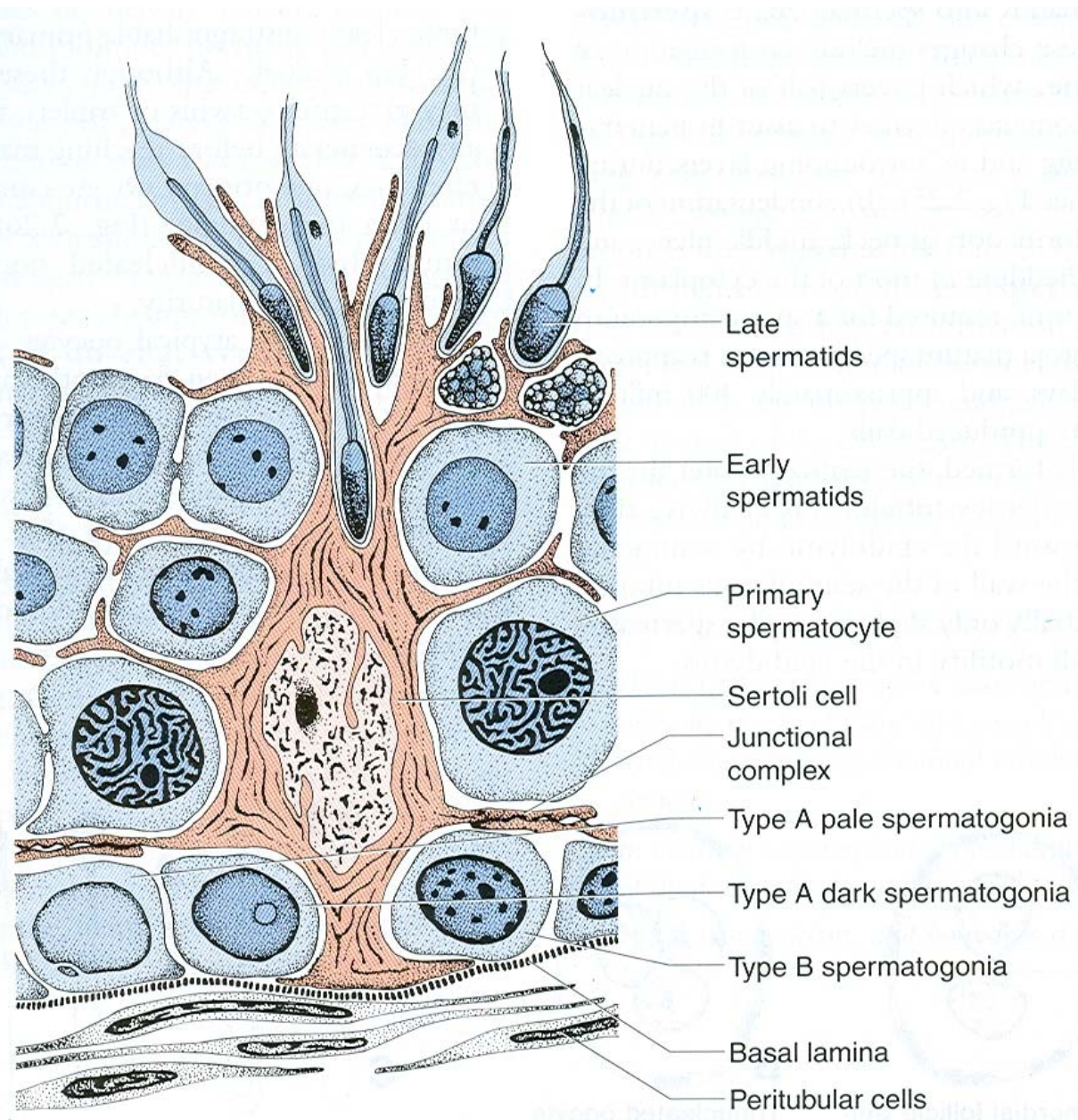
- In male the sex organs are the **testes** which produce spermatozoa (male gametes or sperms), 44xy.
- In female the sex organs are **ovaries** which produce ova (the female gametes), 44xx.

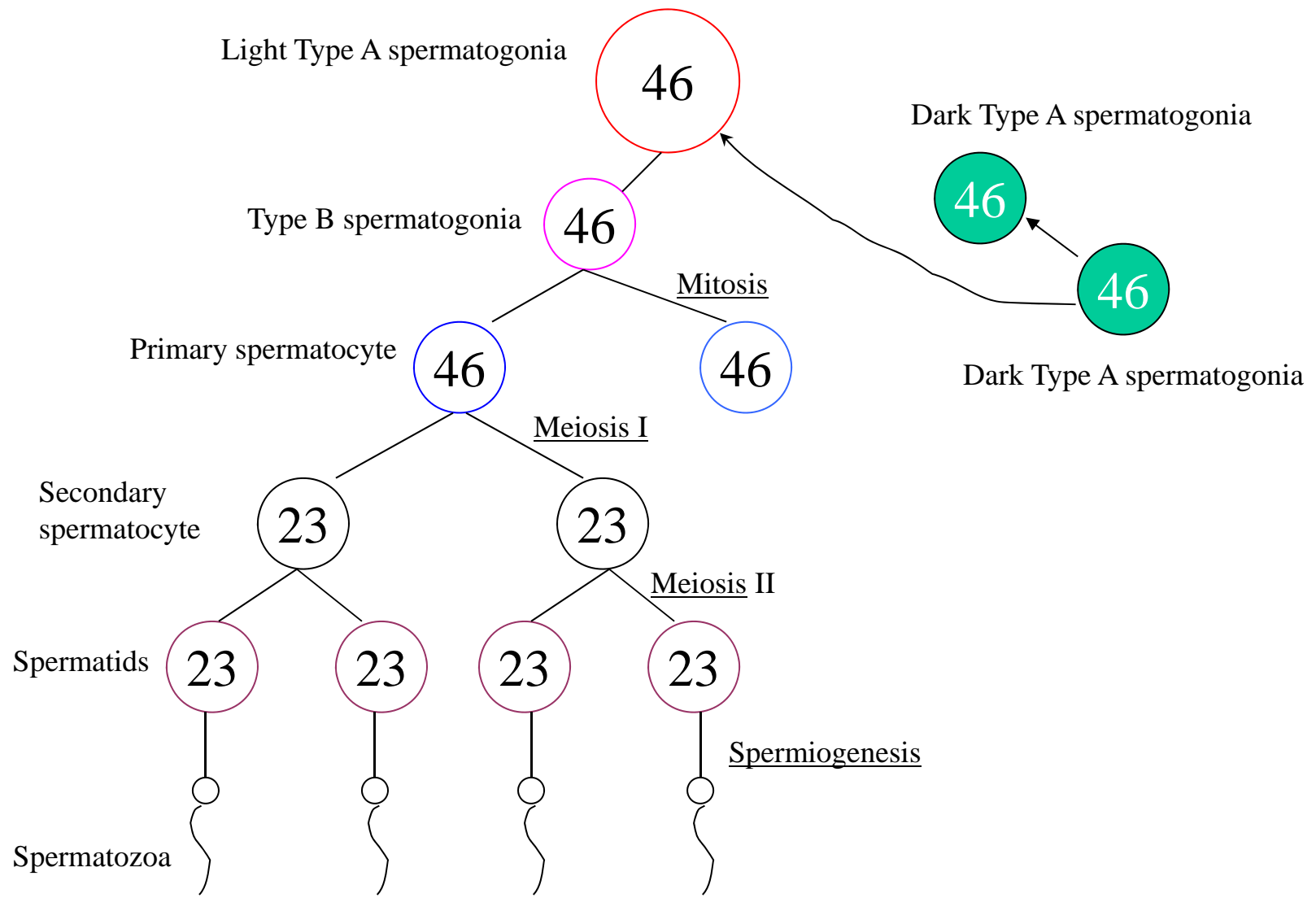
Spermatogenesis

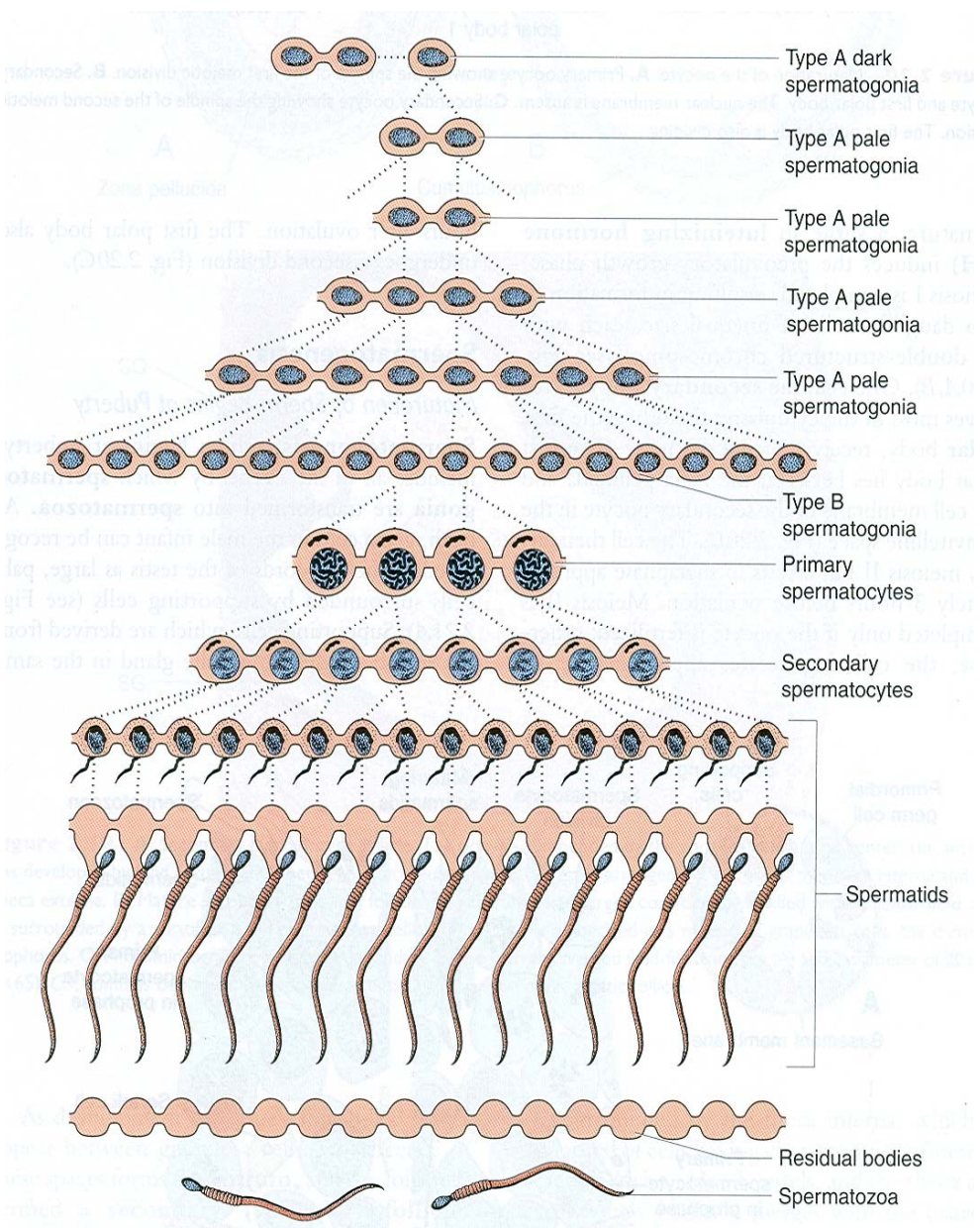
- Total time taken 64 days.
- Starts after onset of puberty (13-16 years).
- Includes all events by which spermatogonia (primordial germ cells) are transformed into spermatozoa, the mature sperms.
- Comprises of three phases:
 1. Spermatocytosis (mitosis)
 2. Meiosis
 3. Spermogenesis

- presence of primordial germ cells in the sex cords (large pale cells). Primordial germ cells transform into spermatogonial stem cells.
- presence of supporting cells known as sertoli or sustentacular cells in the sex cords. Sertoli cells provide nutrition and support.
- Cords change into tubular structures known as seminiferous tubules.









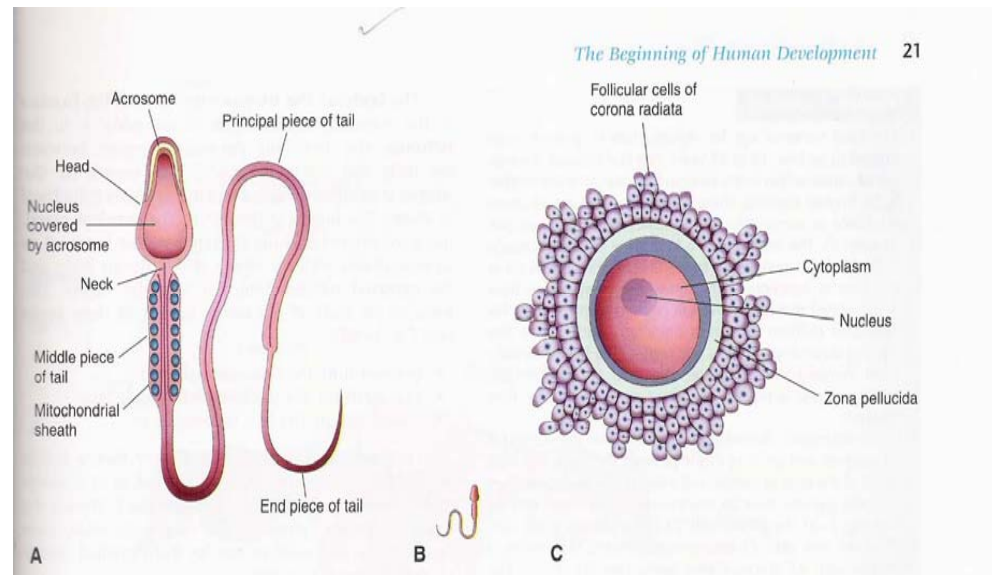
Spermiogenesis

- Spermatid elongates
- Golgi apparatus containing acrosomal granules forms the head cap of sperm at the anterior pole.
- Nucleus condenses
- Centrosome migrates to posterior pole
 - splits into two centrioles
 - form axial sheath
- Mitochondria forms the mitochondrial sheath
- Cytoplasm rearranges as middle, principal and tail piece

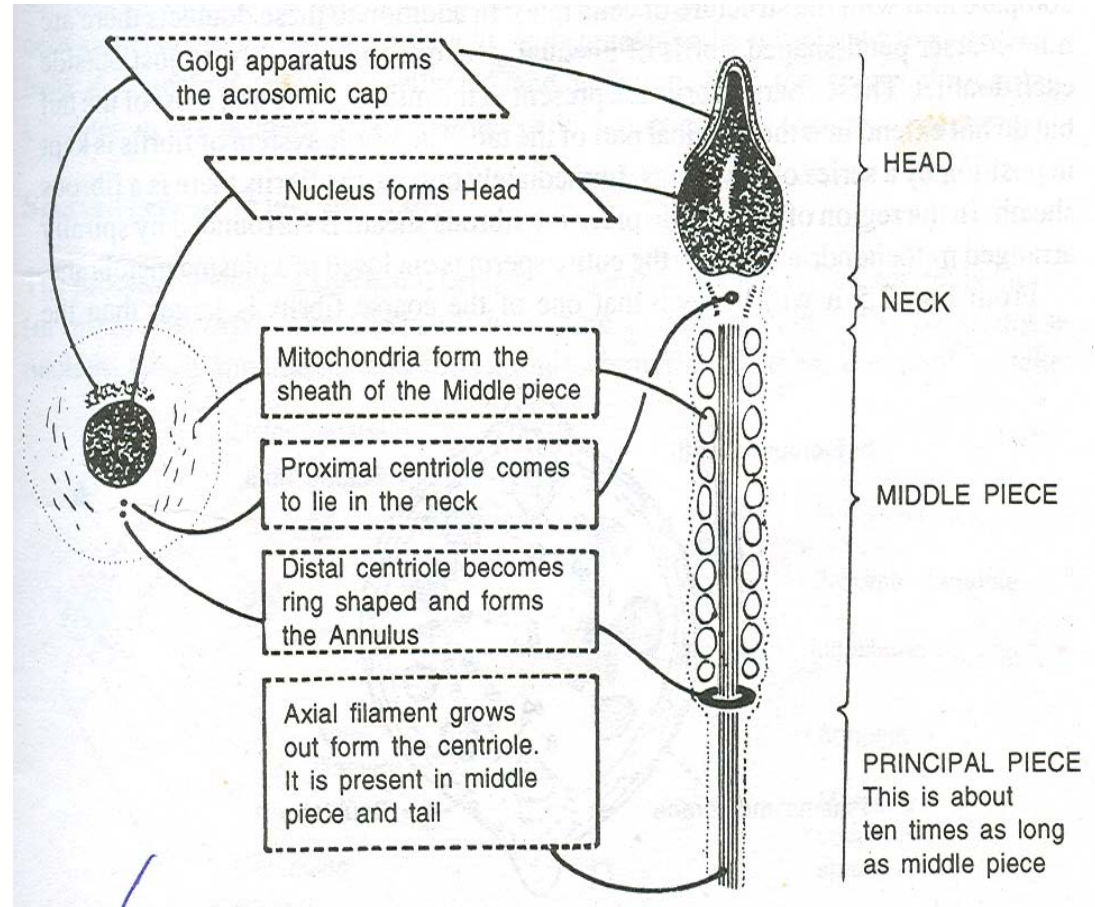
- sperms gain motility in epididymis.
- ejaculated by contractile elements.
- one ejaculate of 2-5 ml has 200-300 million sperms.
- spermatocytosis requires 16 days, meiosis requires 24 days and spermiogenesis about 24 days - total of 64 days .
- Hormonal influence

Structure of a spermatozoa

- 50 microns in length
- has a head, neck, tail
- head is made of nucleus and acrosomal head cap.
- neck comprises of one centriole and two cylinders.
- tail is made of 1.body or middle piece
 2. principal piece
 - 3.end piece



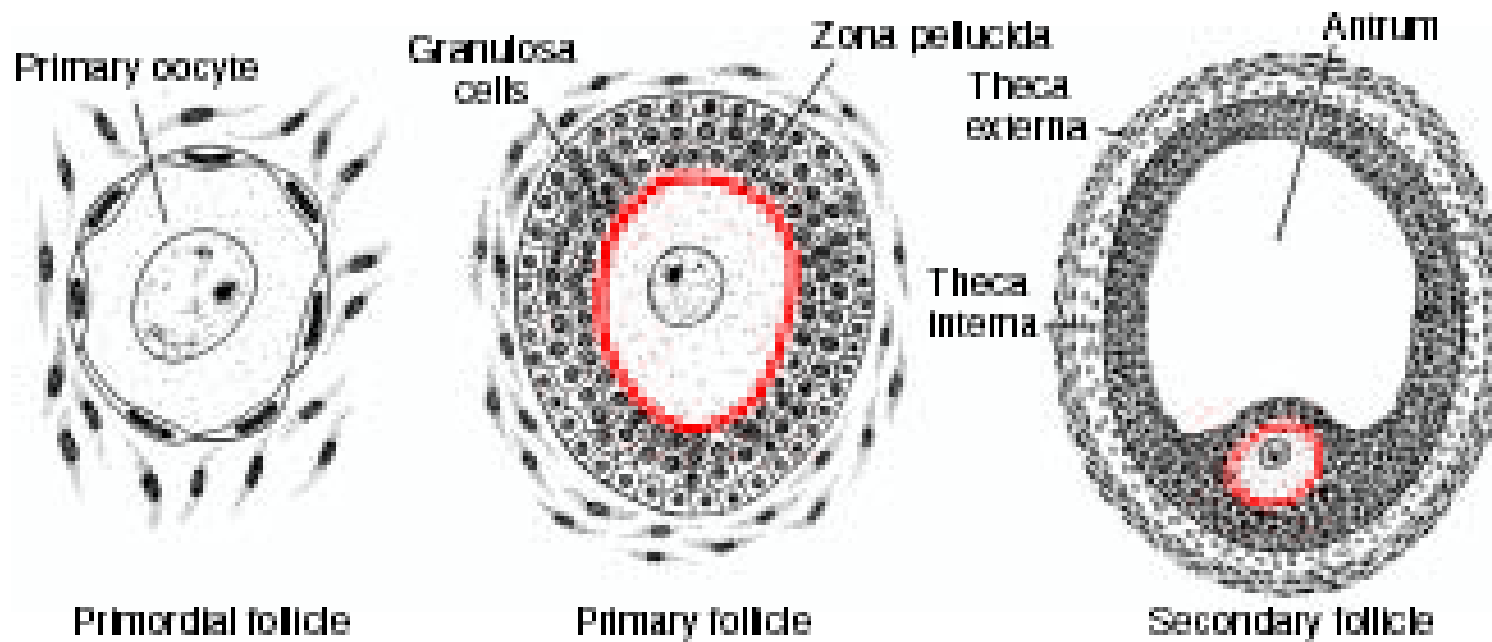
- principal piece has axial filaments, fibrous sheath, cytoplasm and cell membrane.
- end piece comprises of the axial filaments only.
- body made up of axial filaments, mitochondrial sheath, cytoplasm and cell membrane

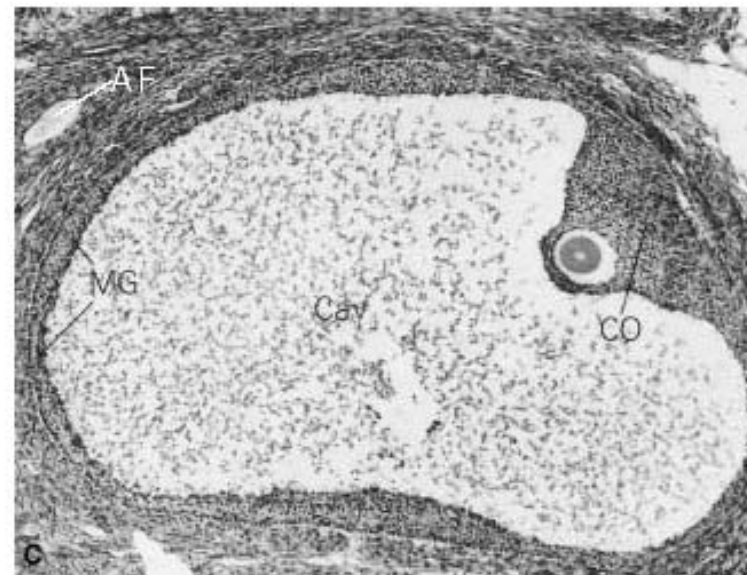
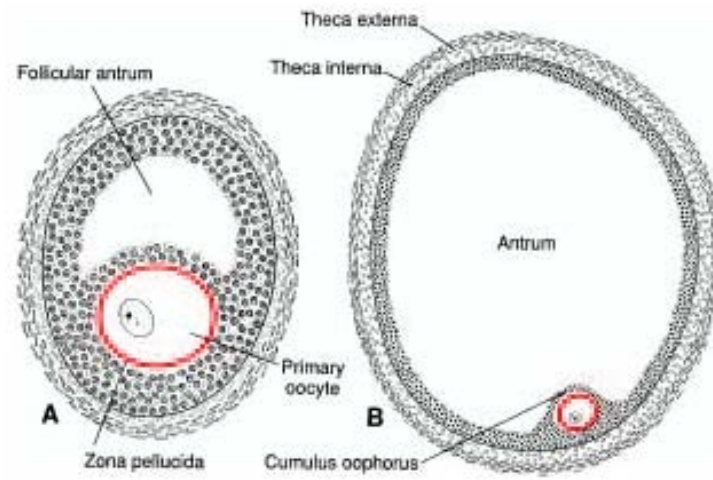


OOGENESIS

- Process of maturation of female primordial germ cells to mature ovum.
- PGC are formed by proliferation of the endodermal cells of the dorsal wall of yolk sac in 3rd week and reach gonads by 5th week.
- PGC undergo rapid mitosis.
- Oogonia increase in size by 7th week.

- Oogonia are surrounded by a layer of flat epithelial cells - follicular cells from surface epithelium (Primary follicle).
- Oogonia undergo further mitosis -by 5th month -7 million – after cell death- 6-8 lakhs oogonia remain.
- Some oogonia undergo meiosis I which stops at prophase (diplotene stage) under OMI.
- These oogonia are now called primary oocytes.





- Birth.
- At puberty: surviving primary oocytes are 40,000.
- Oocyte grows in size.
- Follicular cells become stratified cuboidal --- granulosa cells.
- Granulosa and oocyte secrete a cellular glycoprotein layer --zona pellucida which provides nutrition.
- Stromal cells of ovary form theca folliculi--splits into secretory theca interna and fibrous theca externa.

- Fluid filled spaces appear in granulosa cells – spaces coalesce to form antrum (secondary follicle).
- Granulosa cells surrounding oocyte form cumulus oophorous.
- Above unit is called-- Graafian follicle.
- Each cycle recruits 15-20 follicles.
- One Graafian follicle matures; rest atrophy.

- LH surge –meiosis I is completed.
Secondary oocyte and one polar body formed.
- Polar body lies in perivitelline space.
- Secondary oocyte starts meiosis two--
arrests in metaphase-3 hrs. before
ovulation.
- Above unit is called preovulatory
follicle.

Oogenesis Vs Spermatogenesis

Similarities

- PGC originate from the same source and at the same time.
- Occurs in sex cells.
- Both undergo two reduction divisions-meiosis.
- Cells from columnar epithelium contribute to form supportive cells-sertoli cells in males and follicular cells in females.

Oogenesis Vs Spermatogenesis

Differences

Oogenesis

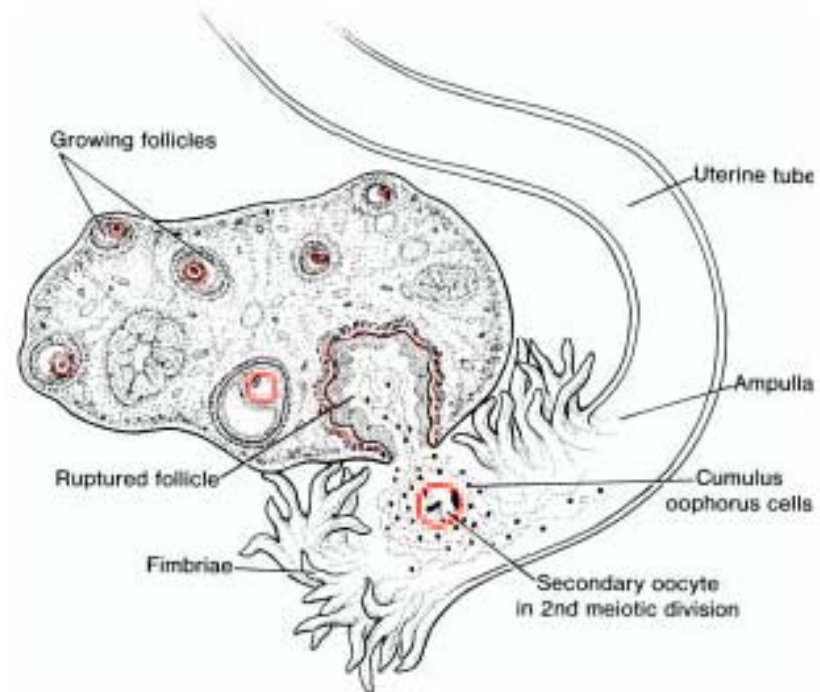
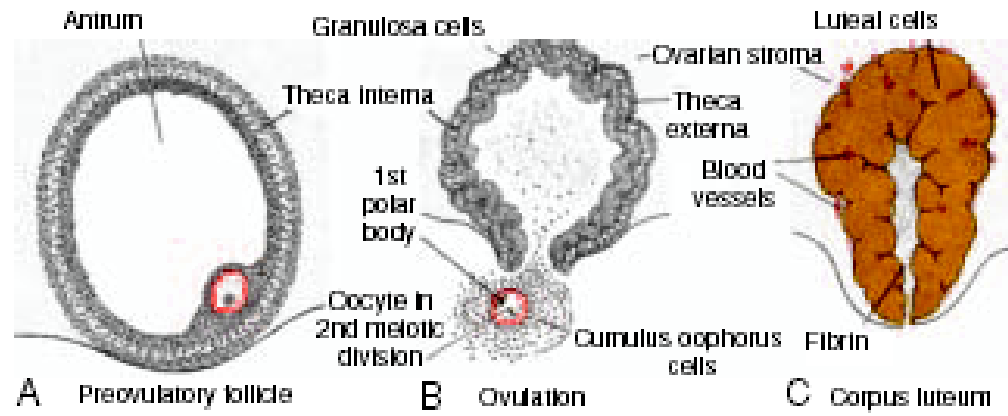
- Differentiation starts in IU life.
- Meiosis is completed only if fertilization occurs.
- Cells may remain dormant for years.
- Cytokinesis is not equal- one main cell and one polar body are formed.
- Secondary oocytes are alike -23x.

Spermatogenesis

- Starts at puberty.
- Both divisions are completed before release of sperms.
- Duration-64 days.
- Equal spermatids.
- Spermatocytes are of two types-23x & 23y.

Ovarian Cycle

- Under the influence of LH & FSH.
- Regular monthly cycles at puberty.
- 15-20 follicles start maturing; only one reaches full maturity; others degenerate
- 1-13 days: proliferation of primary follicle- secondary follicle- Graafian follicle
- 14 day: Ovulation
- Formation of corona radiata
- Oocyte transport
- 15-28 day: Corpus luteum
- Corpus albicans



Ovulation

- LH surge

- surface of ovary bulges

- prostaglandins also increase; contraction of ovarian wall.

- oocyte** and cumulus **oophorous** are extruded.

- cumulus oophorous forms **corona radiata**.

- oocyte is transported by cilia of fallopian tube.

- Cells remaining behind in the ovary develop luteal pigment-----**corpus luteum**.

- If fertilization does not occur –**corpus albicans** is formed in the ovary and shed off.

Corpus Luteum

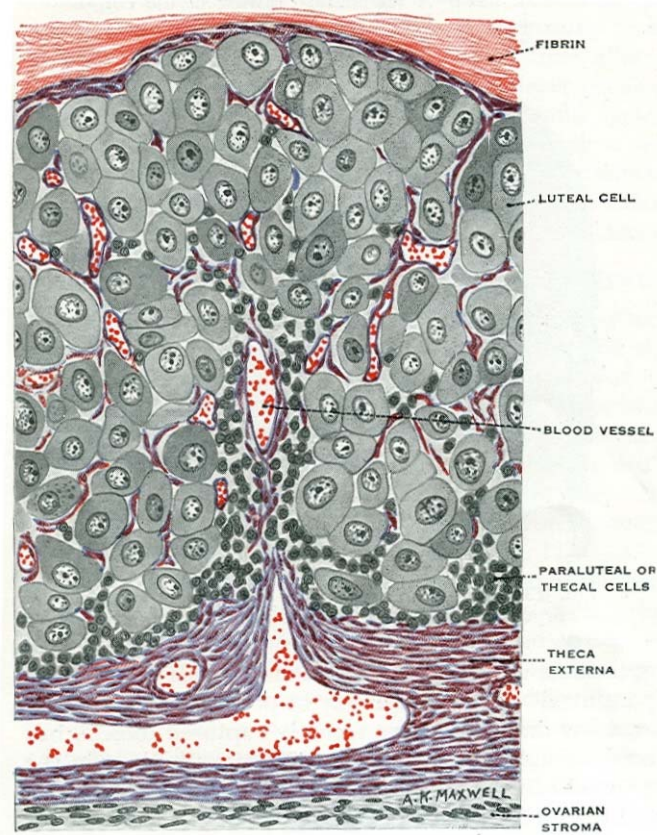
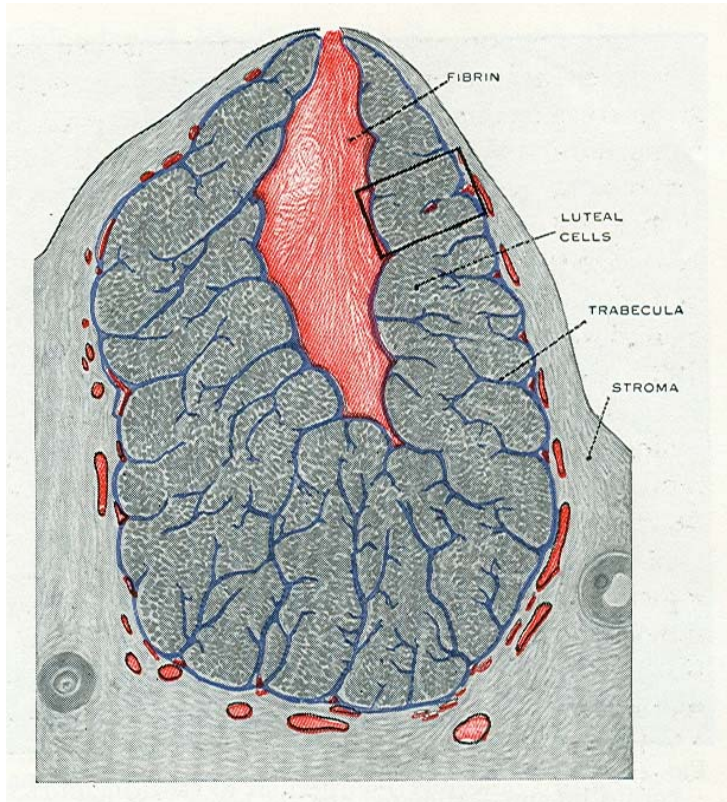
- Formation

Granulosa cells change in to luteal cells.

secrete progesterone

- Corpus luteum of menstruation
(functional for 14 days)

- Corpus luteum of pregnancy
(functional for 3-4 months)



Corpus Luteum

Uterine/Menstrual cycle

PHASES

Menstrual- regular, monthly flow of blood which usually lasts for 3-6 days.

Post-menstrual- repair of endometrium following menstruation.

Proliferative (follicular)- regeneration of surface epithelium.

Growth of all parts of endometrium including glands.

Stratum spongiosum and basale again visible.

Secretory (progestational)- Changes influenced by the progesterone secretion in the corpus luteum of ovary (after ovulation).

-increase in thickness of endometrium.

-secretory activity starts in glands; basal parts become tortuous and dilated.

-endometrium has edematous stratum spongiosum.

-arteries grow rapidly, becomes tortuous and coiled (called as spiral arteries).

Menstruation

If there is no fertilization, progesterone secretion stops after 14-15 days.

-temporary ischemia of spiral arteries occurs 6-8 hours before the onset of menstruation.

-necrosis and shrinkage of superficial layers of endometrium starts.

-with the storage of blood supply, rupture of damaged vessel walls occurs and blood oozes in to endometrial stroma.

-glandular walls degenerate; the secretions mix with blood and connective tissue in endometrium.

-rupture of surface epithelium leading to bleeding in to uterine lumen and from there to outside through vagina.

-contents of menstrual flow are unfertilized ovum, 20-80 ml. of blood, mucin and glycogen from glands, connective tissue and surface epithelium.

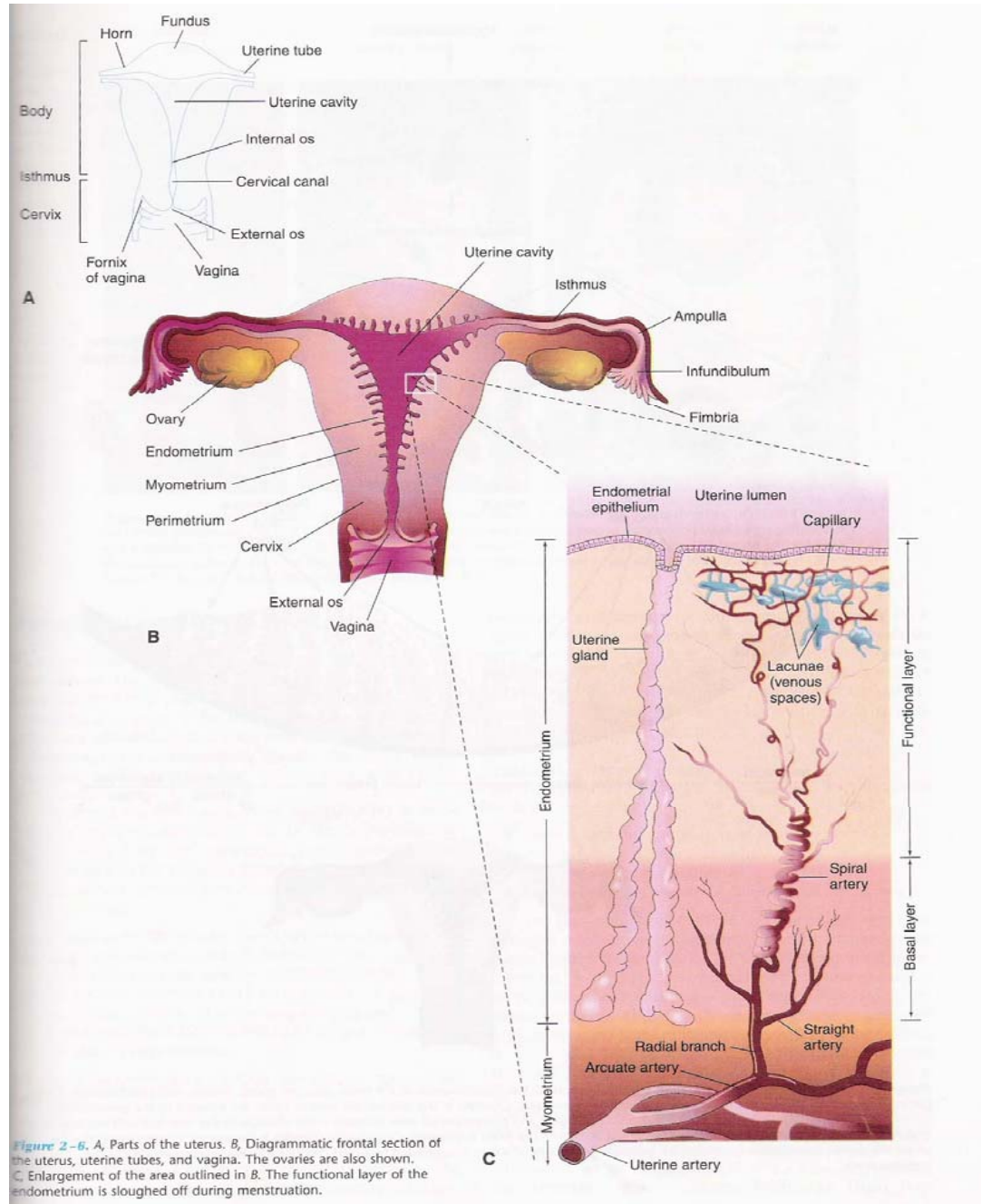
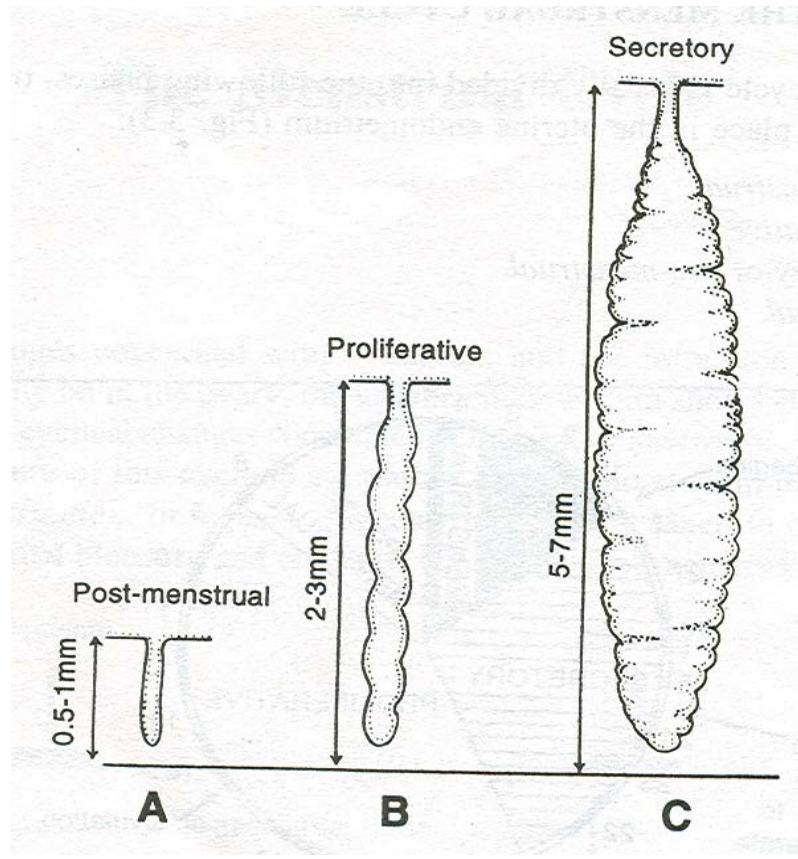
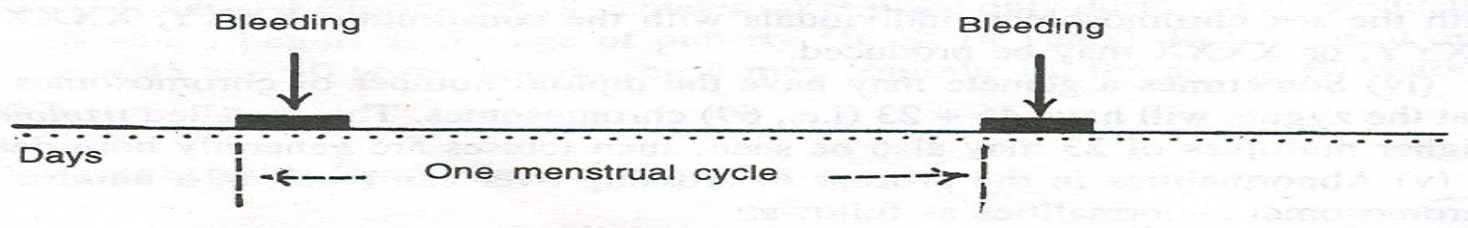
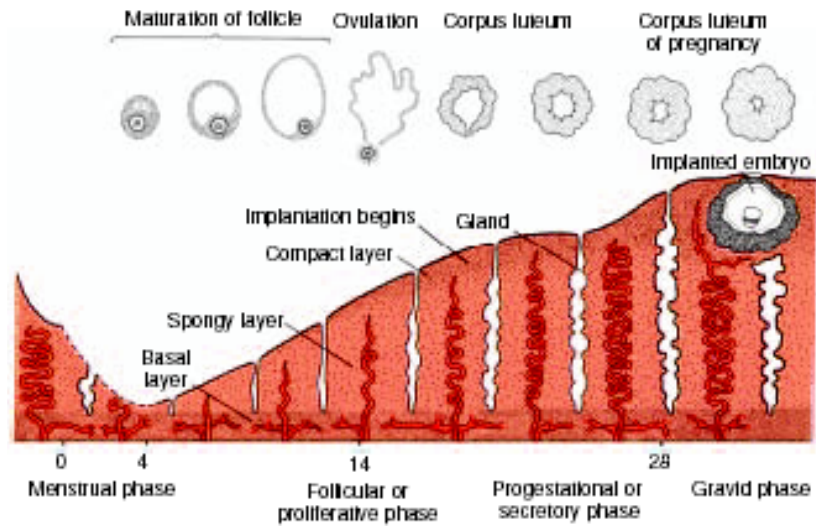
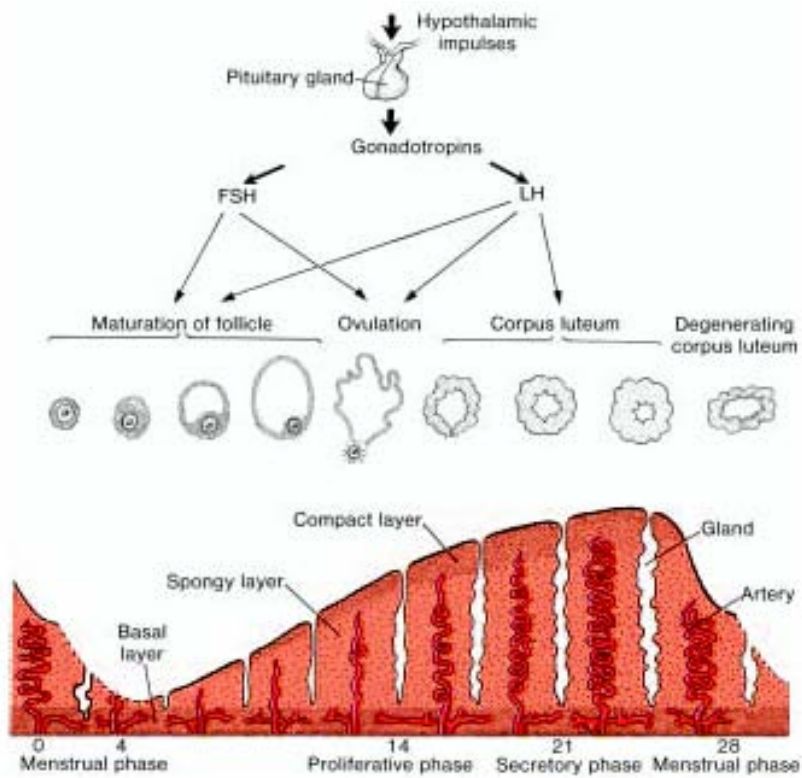


Figure 2-6. A, Parts of the uterus. B, Diagrammatic frontal section of the uterus, uterine tubes, and vagina. The ovaries are also shown. C, Enlargement of the area outlined in B. The functional layer of the endometrium is sloughed off during menstruation.





Contraceptive methods

- Safe period
- Barrier techniques
- Contraceptive pills
- Intrauterine devices
- Surgical

Vasectomy/Tubal ligation

Infertility

- Assisted reproductive technology (ART)
- In vitro fertilization (IVF)
- Gamete intrafallopian transfer (GIFT)
- Zygote intrafallopian transfer (ZIFT)
- Intracytoplasmic sperm injection (ICSI)