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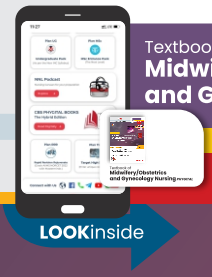


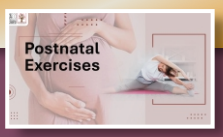
Textbook of Midwifery/Obstetrics and Gynecology Nursing PHYGITAL

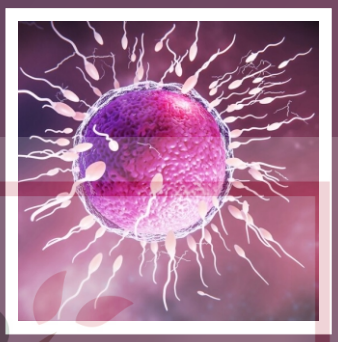
Based on INC Syllabus 2021-22

VI & VII Semester

BONUS CONTENT

10 CONCEPTUAL VIDEOS





Textbook of

Midwifery/Obstetrics and Gynecology Nursing

for BSc Nursing Students

As per the Revised INC Syllabus (2021-22) for BSc Nursing

2nd Edition

What's **New** in this edition?

- Thoroughly revised and updated edition conforming to the latest INC syllabus
- Covers Midwifery/Obstetrics and Gynecology Nursing I and II
- **500+** Images, Line arts, Flowcharts and Tables
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- Perfect amalgamation of Theoretical and Clinical Aspects
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Foreword
Sunita Lawrence

CBSPD Dedicated to Education

Nursing Knowledge Tree An Initiative by CBS Nursing Division

CBS Publishers & Distributors Pvt. Ltd.

Sandeep Kaur

5

Conception and Fetal Development

LEARNING OBJECTIVES

After the completion of the chapter, the readers will be able to:

- Discuss fetopelvic relationship and embryological development.
- Explain placental development, its functions and abnormalities.
- Describe umbilical cord along with its structure, function and abnormalities.
- Know about fetal skull, fetal circulation and fetal nutrition.

CHAPTER OUTLINE

- Fetopelvic Relationship
- Embryological Development
- Placental Development
- Liquor Amnii (Amniotic Fluid)
- Umbilical Cord
- Fetal Skull
- Fetal Circulation
- Fetal Nutrition

KEY TERMS

Amniotic fluid (liquor amnii): It is faintly alkaline watery content of the amniotic sac, which allows growth and free movement of the fetus.
Battledore placenta: The cord is attached to the margin of the placenta. It is associated with low implantation of placenta. There is a chance of cord compression in vaginal delivery leading to fetal anoxia or death.
Embryo: The embryo refers to the growing organism from the second to the eighth week of life.
Embryology: It is the branch of biology that studies the prenatal development of gametes (sex cells), fertilization and development of embryo and fetus.
False knot: When cord appears to be knotted, but instead has kinking of blood vessels within the cord or accumulation of Wharton's jelly on the cord.
Fertilization: It is the process of fusion of the spermatozoon with the mature ovum.
Implantation: It is the process of the embryo attaching itself to the uterine wall.
Oogenesis: It is the process of formation of mature ovum (egg) in the ovary.
Ovulation: Ovulation is a process whereby a secondary oocyte is released from the ovary following rupture of a mature Graafian follicle and becomes available for conception.
Spermatogenesis: It is the process of formation of spermatozoa in testis.
True knot: When real knot has been created in the cord and interferes with circulation.
Vasa previa: The unsupported umbilical vessels in velamentous placenta, lies below the presenting part and runs across the cervical Os called vasa previa. These vessels are torn spontaneously or during rupture of membrane lead to profuse vaginal bleeding and finally fetal death.
Velamentous placenta: The cord is attached to the membranes.

FETOPELVIC RELATIONSHIP

- **Lie:** It is the relationship of the long axis of the fetus with long axis of the mother's uterus. For example, longitudinal, transverse and oblique (Fig. 5.1).
- **Attitude:** It is the relationship of fetal limbs and head to its trunk. Normal attitude is well flexed (Fig. 5.2).
- **Position:** The relationship of the denominator to the six parts of the pelvic brim is known as position or areas of the brim, for example, left anterior, right anterior, right lateral, right posterior, left posterior and left lateral. In vertex presentation occiput is the denominator, if occiput points to the left side on the anterior side of the brim, it is known as left occipito anterior position (Fig. 5.3).
- **Presentation:** It is the part of the fetus which lies in the lower pole of the uterus, or at the pelvic brim. For example, vertex, brow, face, shoulder cord presentation (Fig. 5.4).
- **Presenting part:** It is the part of the fetus, which lies over the Os during labor. For example, in LOA position of the vertex, the presenting part is posterior part of the right parietal bone.
- **Denominator:** It is the part of the presentation that determines or indicates the position. For example, in vertex presentation the occiput, in breech presentation the sacrum, in face presentation the mentum, in shoulder presentation the acromion process of the scapula.

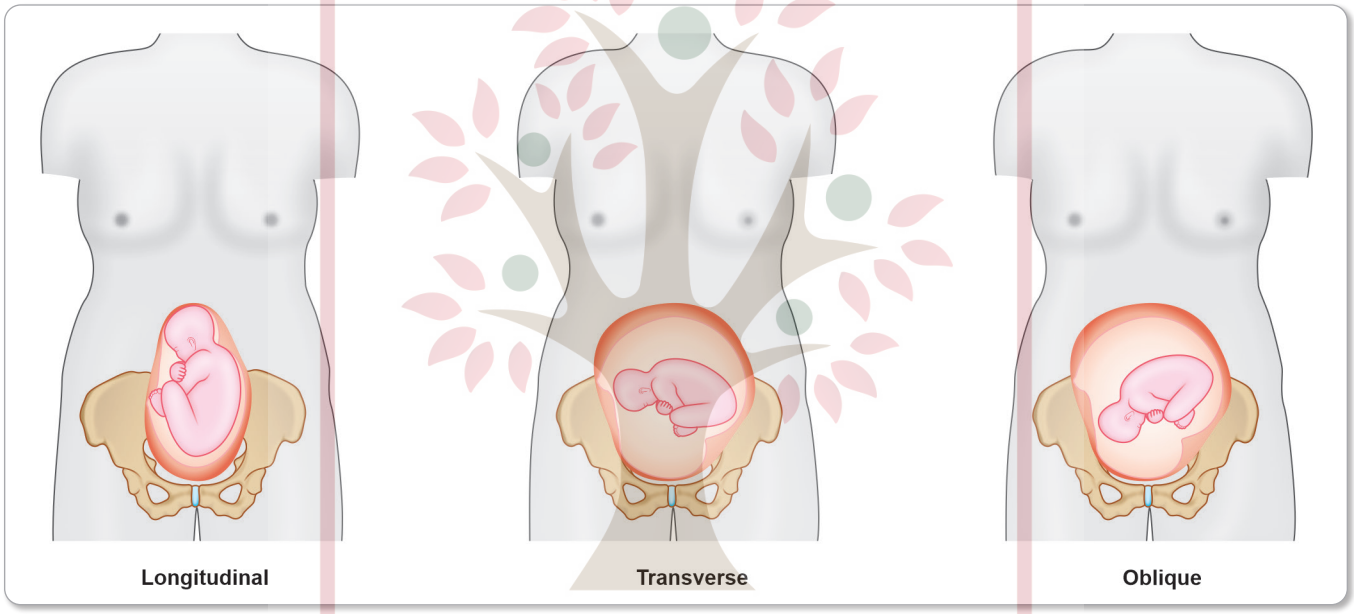


Fig. 5.1: Fetus lie in uterus

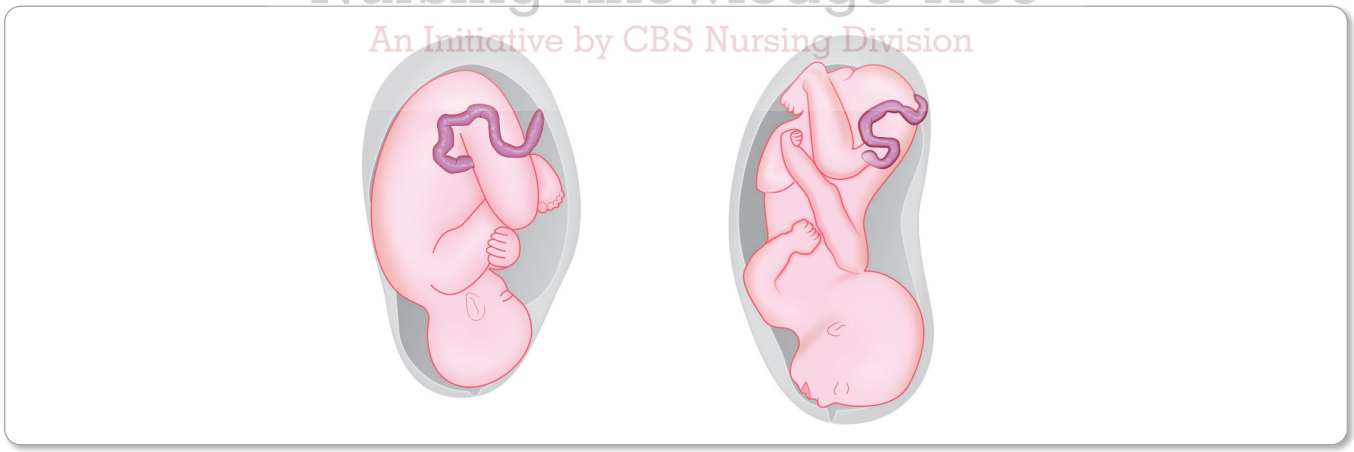


Fig. 5.2: Normal and extended attitude

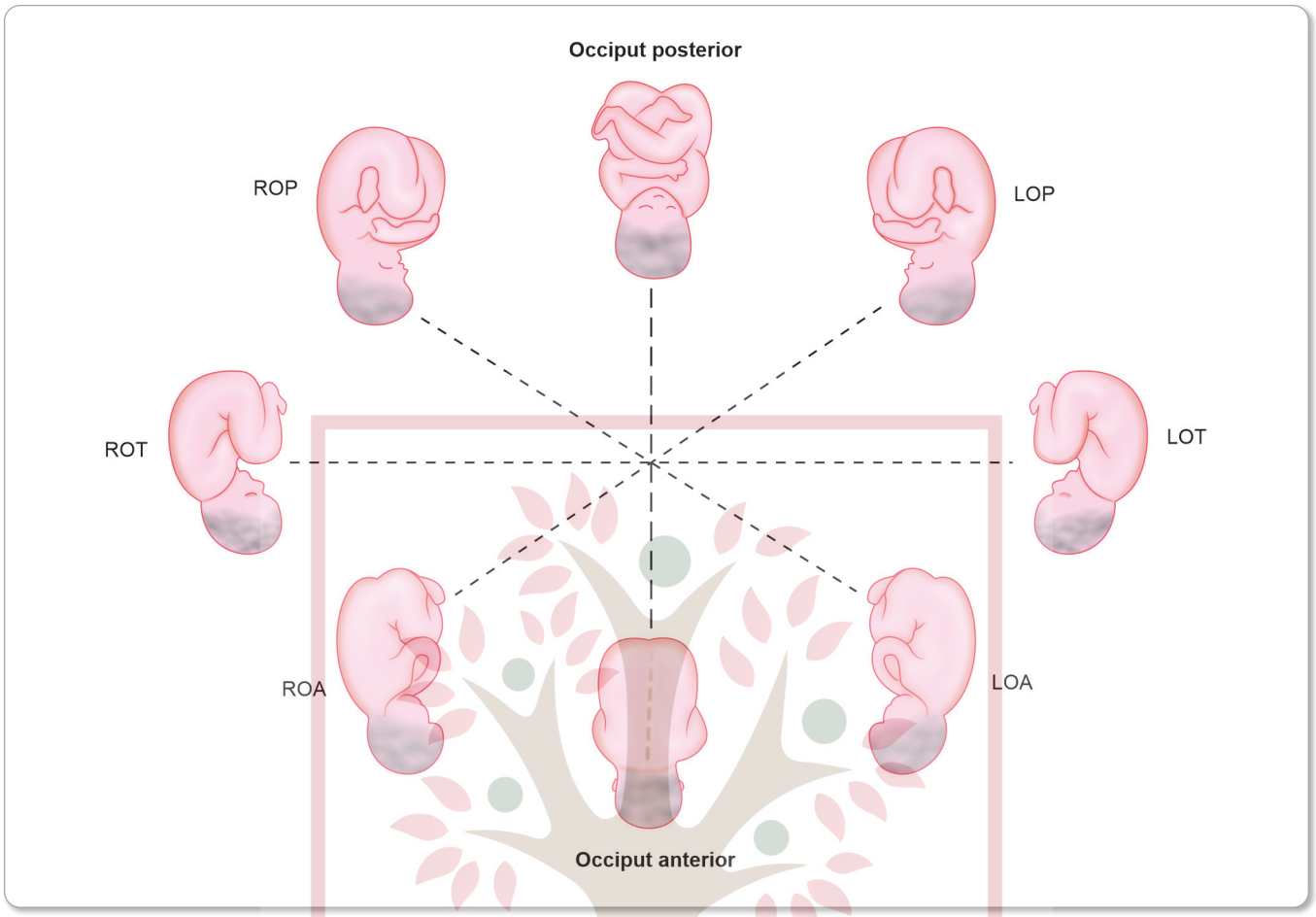


Fig. 5.3: Fetal positions in uterus

Abbreviations: ROA, Right occiput anterior; ROT, Right occiput transverse; ROP, Right occiput posterior; LOP, Left occiput posterior; LOT, Left occiput transverse; LOA, Left occiput anterior.

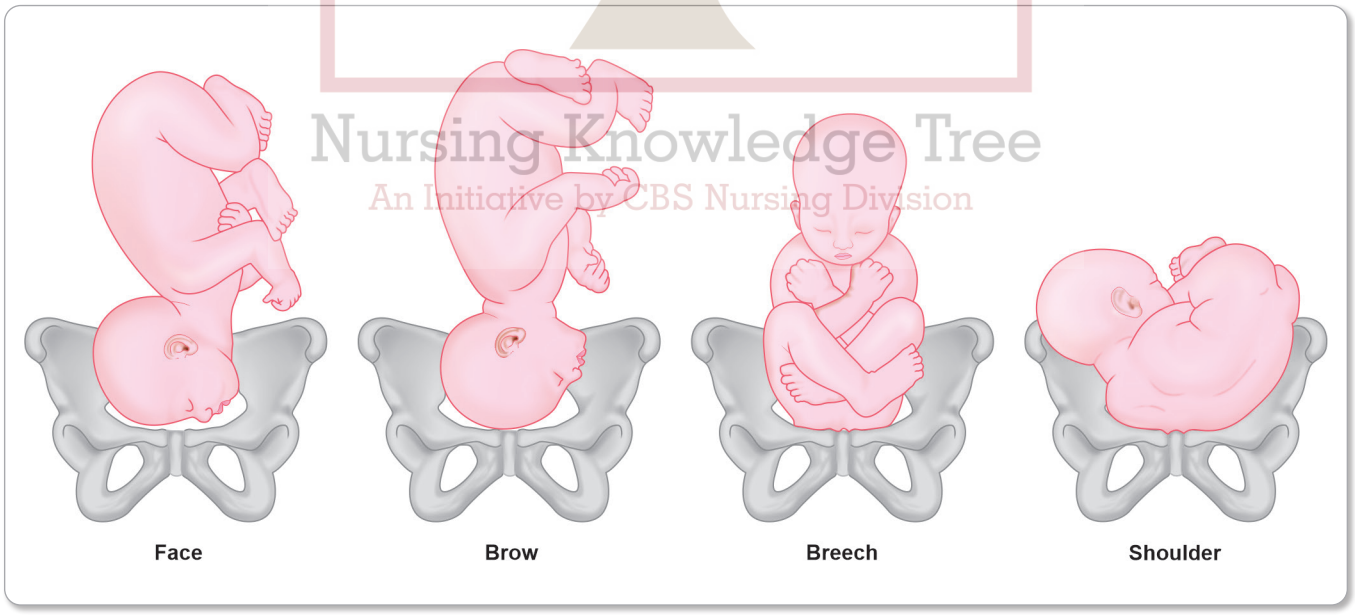


Fig. 5.4: Abnormal presentations of fetus in womb

EMBRYOLOGICAL DEVELOPMENT

Embryology: It is the branch of biology that studies the prenatal development of gametes (sex cells), fertilization and development of embryo and fetus.

The embryonic stages between conception and birth are shown in Figure 5.5.

The stage after conception is zygote and upon cell division, it becomes morula. The morula becomes blastocyst and attaches to the uterus and 6–12 days after conception, the blastocyst turns into embryo. At 10 weeks, the fetal period begins and embryo is termed as a fetus.

Stages of Fetal Development

The stages of fetal development are as follows:

- Gametogenesis
  - Spermatogenesis
  - Oogenesis
  - Ovulation
- Fertilization
- Implantation
- Decidua
- Development of fertilized ovum/embryo
- Development of fetus.

Gametogenesis

It is the process of formation of male and female gametes in gonads.

- **Spermatogenesis** is the process of formation of spermatozoa in testis. The process is described in Figure 5.6A.

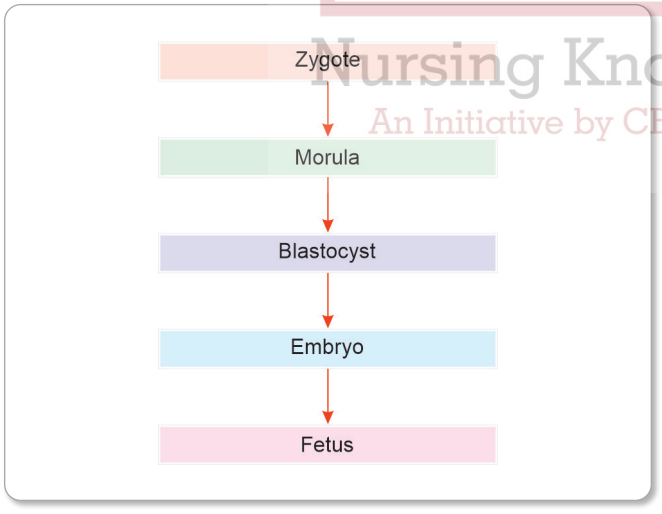


Fig. 5.5: Embryonic stages

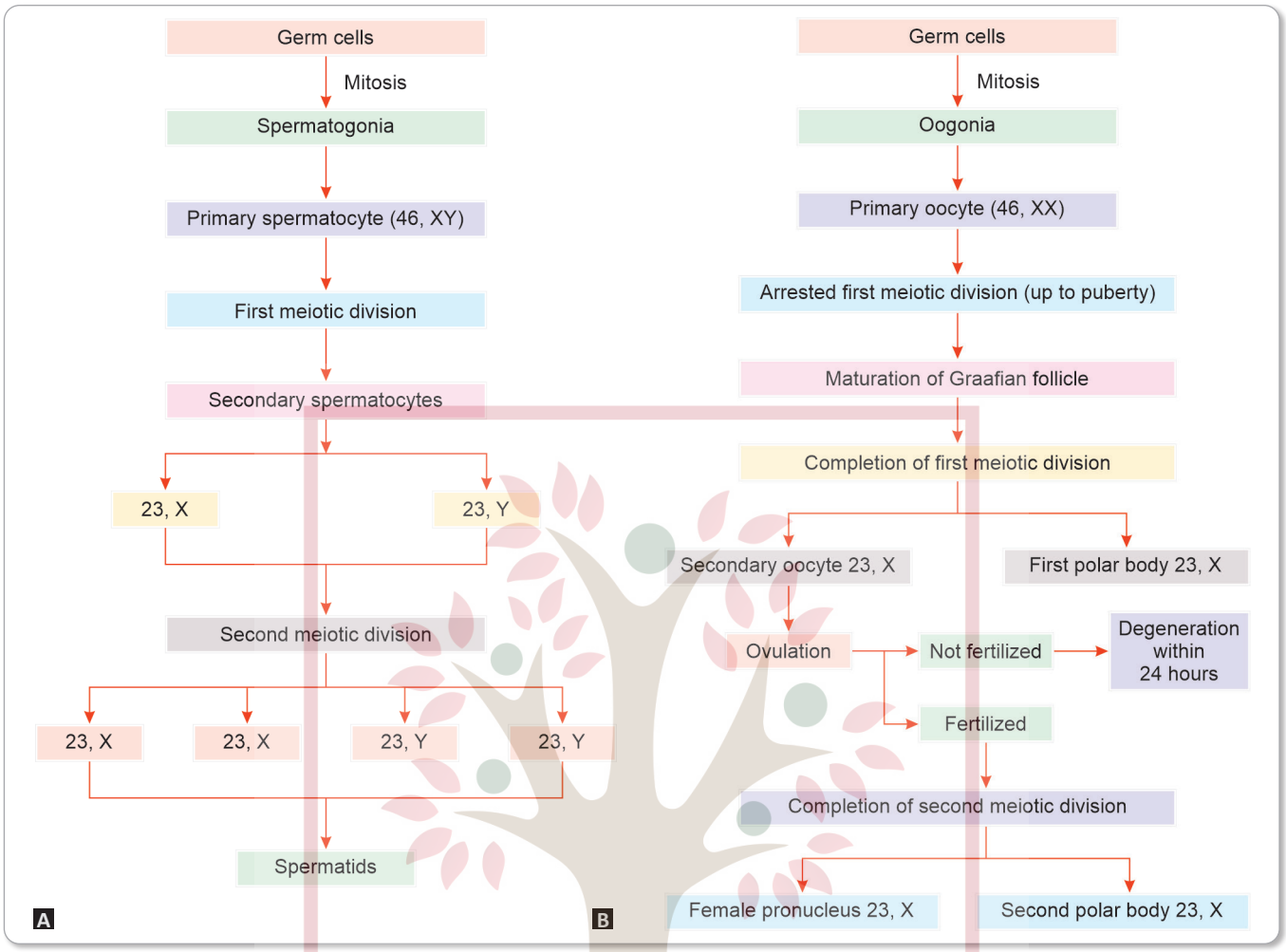
- **Oogenesis** is the process of formation of mature ovum (egg) in the ovary. The process is discussed in Figure 5.6B.
- **Ovulation:** Ovulation is a process whereby a secondary oocyte is released from the ovary following rupture of a mature Graafian follicle and becomes available for conception. Only one secondary oocyte is likely to rupture in each ovarian cycle which starts at puberty and ends in menopause.

Mechanism

- Ovulation, prompted by luteinizing hormone from anterior pituitary occurs when the mature follicle ruptures and releases secondary oocyte into peritoneal cavity.
- The ovulated secondary oocyte, ready for fertilization is still surrounded by zona pellucida and few layers of cells called corona radiata.
- If not fertilized, secondary oocyte degenerates in a couple of days.
- If a sperm passes through corona radiata and zona pellucida and enters the cytoplasm of the secondary oocyte, then fertilization takes place.

Fertilization

- It is the process of fusion of the spermatozoon with the mature ovum.
- Fertilization is most likely to occur if intercourse takes place around the time of ovulation. More often, fertilization occurs in the ampullary part of the uterine tubes/fallopian tubes (Fig. 5.7).
- During ejaculation, out of hundreds of millions of sperms that are deposited in the vagina, only a few thousand capacitated spermatozoa enter the uterine tube while only 300–500 reach the ovum due to muscular contractions of the uterine tube. It takes few minutes for the sperm to reach the fallopian tube.
- The mature sperm penetrates the zona pellucida and cell membrane surrounding ovum. After the entry of one sperm, the membrane is sealed to prevent entry of any further sperm. Following penetration of the sperm into the ovum, the egg is fertilized and becomes an embryo.
- The fertilized ovum (zygote) with 46 chromosomes continues its passage through the fallopian tubes and undergoes division into 2 cells →4 cells →8 cells →16 cells and so on, until a mulberry-like ball of cells is formed called morula.
- On 4th day, morula reaches the uterine cavity.



Figs 5.6A and B: **A.** Spermatogenesis; **B.** Oogenesis

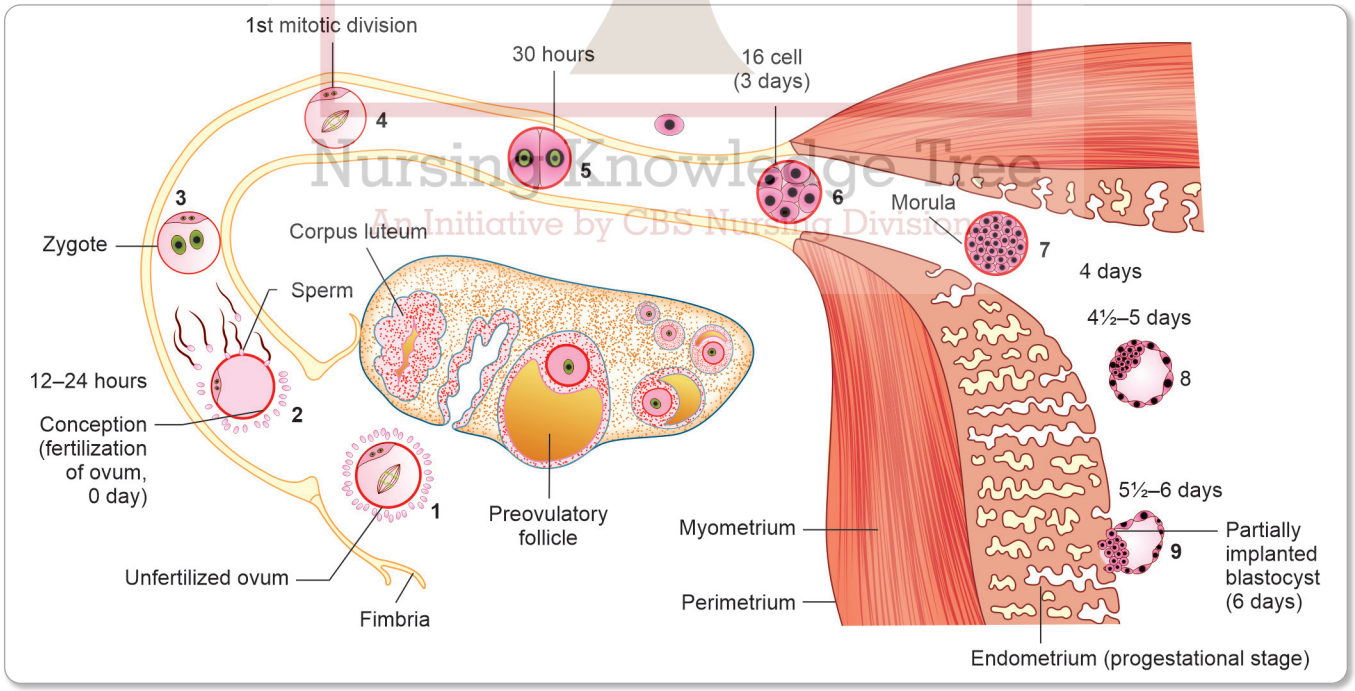


Fig. 5.7: Stages of development-early embryo

- On 4th–5th day, morula is covered by a film of mucus. The fluid passes through the canaliculi of the zona pellucida which separates the cells of the morula and is called blastocyst.
- At this point, cells of zygote differentiate into two distinct types:
  i. **Embryoblast cells:** These cells continually divide into what will become the embryo, the fetus itself.
  ii. **Trophoblast:** These cells form the placenta that attach against the uterine wall to nourish the embryo.

Implantation

- Implantation is the process of the embryo attaching itself to the uterine wall.
- Implantation occurs in the endometrium of the anterior or posterior wall of the body of uterus near the fundus on 6th day which corresponds to the 20th day of a regular menstrual cycle. If implantation is successful, the developing placenta will begin to produce beta hCG that is easily detectable in the urine and blood.

Implantation goes through four stages:

1. Apposition
2. Adhesion
3. Penetration
4. Invasion

The implantation is controlled by the immunomodulatory role of various cytokines, many local peptides like epidermal growth factors, insulin-like growth factors and prostaglandins.

Decidual Stage

The decidua is the endometrium of the gravid uterus. It is so named because much of it is shed following delivery. Endometrium grows 4 times in thickness due to increased secretion of estrogen. Progesterone also helps in increasing the size of blood vessels.

The increased structural and secretory activity of the endometrium that is brought in response to progesterone following implantation is known as decidual reaction. Changes occur in all the components of the endometrium but most marked at the implantation site and around the maternal blood vessels.

The well-developed decidua differentiates into three layers:

1. Superficial compact layer
2. Intermediate spongy layer
3. Thin basal layer

After the interstitial implantation of blastocyst into the compact layer of the decidua, the different portions of the decidua are renamed as:

- **Decidua basalis:** It lies between the blastocyst and uterine muscle. This part later forms placenta.
- **Decidua capsularis:** This is the superficial compact layer which overlies blastocyst. With fetal growth, the decidua capsularis bulges into the uterine cavity and fuses with the decidua parietalis.
- **Decidua parietalis:** This is the decidua lining the rest of the uterine cavity.

Development of Fertilized Ovum/Embryo

After the blastocyst embeds into endometrium, outer trophoblastic cells proliferate to form three layers:

1. **Syncytiotrophoblast:** It is the outer layer, which makes nutrients in the maternal blood accessible to the developing embryo.
2. **Cytotrophoblast:** Inner layer, which produces beta hCG hormone.
3. **Mesoderm:** The third layer, which develops to chorionic vesicle with its membrane called chorion.
   It forms body stalk and umbilical cord.

The trophoblast develops to form the placenta and inner cell mass develops to form fetus. The cells differentiate into the following three layers:

1. **Ectoderm:** Develops into central and peripheral nervous system and the epidermis.
2. **Endoderm:** Forms the dermis, skeleton, urinary bladder, skeletal and smooth muscles.
3. **Mesoderm:** Forms heart, blood vessels, liver, pancreas, bones and muscles.

Embryo

The word embryo (Greek: Swelling within) refers to the growing organism from the second to the eighth week of life. During this time, it develops from a tiny cell cluster into a little growth of about 1 inch in length.

As this development proceeds, the placenta, a special organ of interchange, begins to grow between the embryo and uterus. The embryo is connected to the placenta by the umbilical cord. The placenta acts as filter and barrier. It allows the embryo (and in later stage) the fetus, to absorb food and oxygen from mother's blood and to eliminate CO_2 and other wastes from its own blood in return. At the same time, however, the two blood systems remain completely separate.

Fetal Growth and Development

Fetal development begins on the day of fertilization—when one sperm penetrates the ovum (egg) and unites with it to form one cell. The fertilized ovum undergoes massive cell division. About three to four days later, when the fertilized

ovum in the fallopian tube has reached the uterus, it begins to implant itself into the soft lining of the uterus between the end of the first week and the beginning of the second week after ovulation.

The following are the descriptions of various stages of gestational ages:

- **3-weeks gestational age:** A pregnant woman may notice her first missed menstrual period at the end of the second week after conception, or about four weeks after the first day of her last normal period.
- **4-weeks gestational age:** During this period:
  - Pregnancy tests become positive.
  - Heart begins to form.
  - Blood circulation begins.
- **6-weeks gestational age (Fig. 5.8):** During this period:
  - The head and upper body are well developed.
  - The eyes have begun to form.
  - Limb buds begin to appear that forms the arms and legs.
  - The heart begins to beat.
  - The neural tube has developed which will give rise to the brain and spinal cord.
- **8-weeks gestational age (Fig. 5.9):**
  - The embryo now has a four chambered heart.
  - Blood is being pumped through the umbilical cord to and from the embryo.
  - The vertebral (spinal) column is developed and visible but is composed of cartilage at this stage.
  - Electrical activity begins in the developing brain and nervous system.
  - The fingers begin to develop.
  - The embryo is surrounded by bluish amniotic sac that contains amniotic fluid which protects the embryo.

Fig. 5.9: 8-weeks gestational age

- **10-weeks gestational age (Fig. 5.10):** During this period:
  - The embryo reaches a transition point and called fetus.
  - The fetus shows distinct human appearance.
  - The head is about half the size of the fetus and the tail has disappeared.
  - The first real bone cells begin to replace the cartilage.
  - Eyelids are formed.
  - Arms, legs, fingers and toes are distinctly visible.
- **12-weeks gestational age:** During this period:
  - The eyelids fuse together.
  - Fingernails are developing.

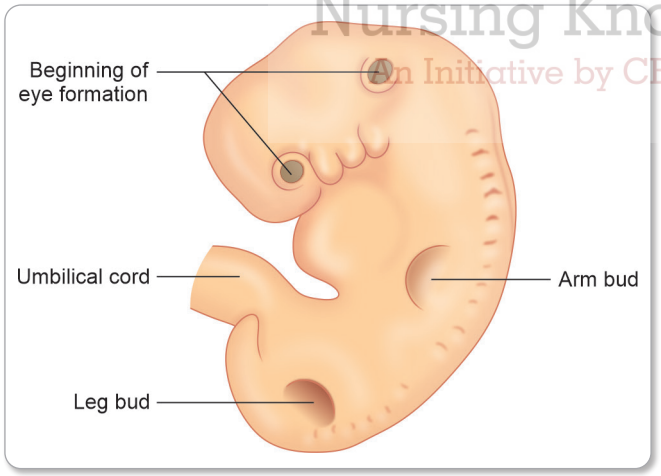


Fig. 5.8: 6-weeks gestational age

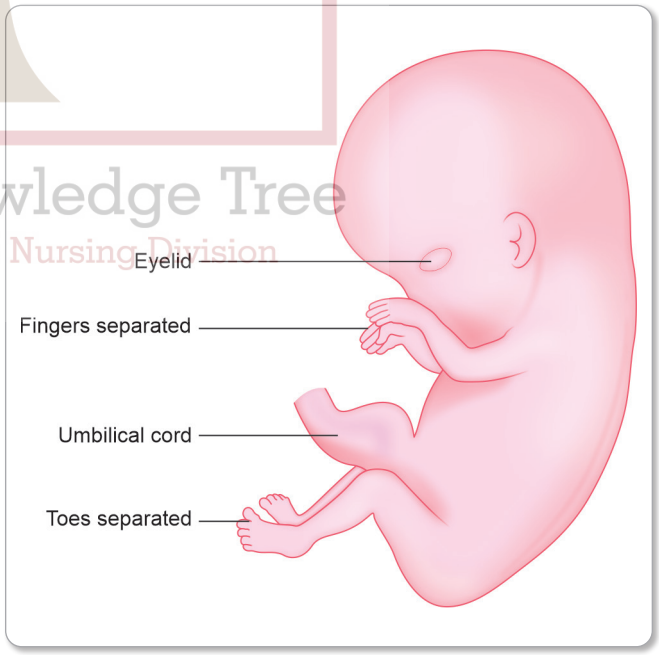


Fig. 5.10: 10-weeks gestational age

- Between 10 and 12 weeks, the fetus begins small, random movements that are too slight to be felt by the mother.
- Fetal heartbeat can be detected electronically.
- All major body organs are formed but reach their maturity during the rest of the pregnancy.

- **14-weeks gestational age:** During this period:
  - Fetus is about 3½ inches long and weighs about 1½ ounces.
  - Blood begins to form in the bone marrow.
  - The arms are in proportion to the body.
  - The fetus now sleeps and awakens. The mouth of the fetus is able to open and close.
  - The fetus is able to swallow and the kidneys are able to make urine.
  - The fetus is able to move arms, legs, head and neck.
- **16-weeks gestational age:** During this period:
  - The fetus is about 5–6 inches long and weighs about 3–4 ounces.
  - By this age, it is possible to distinguish the sex of the fetus.
  - The head is erect and the legs are developing.
  - Fine hair, called lanugo, has begun to grow on the head.
- **18-weeks gestational age (Fig. 5.11):** During this period:
  - The fetus is about 6 inches long and weighs about 4½ ounces.
  - The body and facial features (nose, lips and ears) of the fetus are now recognizable.
  - Scalp hair is present.

Fig. 5.11: 18-weeks gestational age

  - The fetus is able to respond to sound.
  - A fetus at this age will be unable to survive if born prematurely because it is much too small and the organs are too immature.
- **20-weeks gestational age:** During this period:
  - The fetus is about 6½ inches long and weighs about 5–8 ounces.
  - The oil glands in the skin, called sebaceous glands, begin to work.
  - The mother will be able to feel the fetus move, kick and punch. This is called quickening.
  - The fetus has been observed to do thumb sucking on ultrasound. The fetus at this stage has the reflex ability to suck and grasp. It may also experience hiccups.
- **22-weeks gestational age:** During this period:
  - The fetus is about 9 inches long and weighs about 1 pound.
  - Head and body hair called lanugo thickly covers the fetus.
  - The lower limbs are fully formed.
  - Toenails have begun to develop.
- **24-weeks gestational age:** During this period:
  - The fetus is about 12 inches long and weighs about 1½–2 pounds.
  - The fetus begins to gain weight steadily, but still appears "scrawny".
  - The head is still quite large compared to the rest of the body.
  - The skin is typically wrinkled and red.
  - Eyebrows and eyelashes are recognizable.
  - Researches show that 60% of the infants born at this time will be able to survive but need extensive Intensive Care Nursery (ICN) stays. Forty to fifty percent of those that survive to their first birthday may have a permanent disability.
- **26-weeks gestational age:** During this period:
  - The fetus is now about 13 inches long and weighs about 2 pounds.
  - The eyelids open and close.
  - The fetus can respond to sounds that occur both inside the mother's body and outside in the mother's surroundings.
- **28-weeks gestational age:** During this period:
  - The fetus is about 13½ inches long and weighs about 2¼ pounds.
  - The thin, red, wrinkled skin of the fetus is covered with a white cheese-like substance called vernix caseosa that protects the skin from the drying action of the amniotic fluid.

- Eyelashes and eyebrows are present.
- The fetus has a good head of hair.
- Approximately 91% of the infants born at this age will survive if born at a hospital that provides expert high-risk newborn care. Only 15% of these infants will have lengthy hospitalizations and permanent disabilities.

- **30-weeks gestational age:** During this period:
  - The fetus is now about 14 inches long and weighs about 2½ pounds.
  - The lungs of the fetus become more mature with each week that is spent in the uterus. However, if preterm delivery is expected Dexamethasone therapy is instituted 48 hours before delivery.
- **32-weeks gestational age:** During this period:
  - The fetus is now approximately 16 inches long, about the length of a football, and weighs 3–4 pounds.
  - The fetus continues to grow and mature.
  - The body is filling out or "fattening up."
  - Vernix caseosa continues to form a thick coat on the skin.
  - Toenails are fully formed.
  - About 97% of the infants born at this time will survive with appropriate high-risk newborn care. Some will have permanent disabilities. Most of the babies will spend a few weeks in the Intensive Care Nursery.
- **34-weeks gestational age:** During this period:
  - The fetus is about 17½ inches long and weighs about 4–5 pounds.
  - Visible fetal movements and kicks can be seen by watching the mother's abdomen.
  - The fingernails reach the end of the fingertips.
  - The skin is pink and smooth.
  - Most of the babies born at 34 weeks gestational age will be discharged home with their mothers and not require ICN care.
- **36-weeks gestational age:** During this period:
  - The fetus is about 19 inches long and weighs about 5–6 pounds.
  - The fetus has fully-formed limbs with fingernails and toenails.
  - The fetus has soft earlobes with little cartilage.
  - Lanugo disappears from the face but remains on the head.
  - Muscle tone is developed and the fetus can turn and lift its head.
  - An infant born at this time has an excellent chance of survival with proper care.
- **38-weeks gestational age:** During this period:
  - The fetus is about 19½ inches long and weighs about 6 pounds.
  - Skin on the face and body becomes smooth.
  - The head continues to be the largest body part.
  - The body usually appears plump.
  - Lanugo is left only on the shoulders and upper body.
  - Toenails reach the toe tips.
  - The fetus can grasp firmly.
  - The pregnancy is considered full term and the baby is ready to be born anytime between now and 42 weeks.
- **40-weeks gestational Age:** During this period:
  - The baby is 20 inches or more in length and weighs 6½–9 pounds.
  - In males, the testicles are fully descended into the scrotum.
  - The chest is prominent; the breasts protrude.
  - Fingernails extend beyond the fingertips.

PLACENTAL DEVELOPMENT

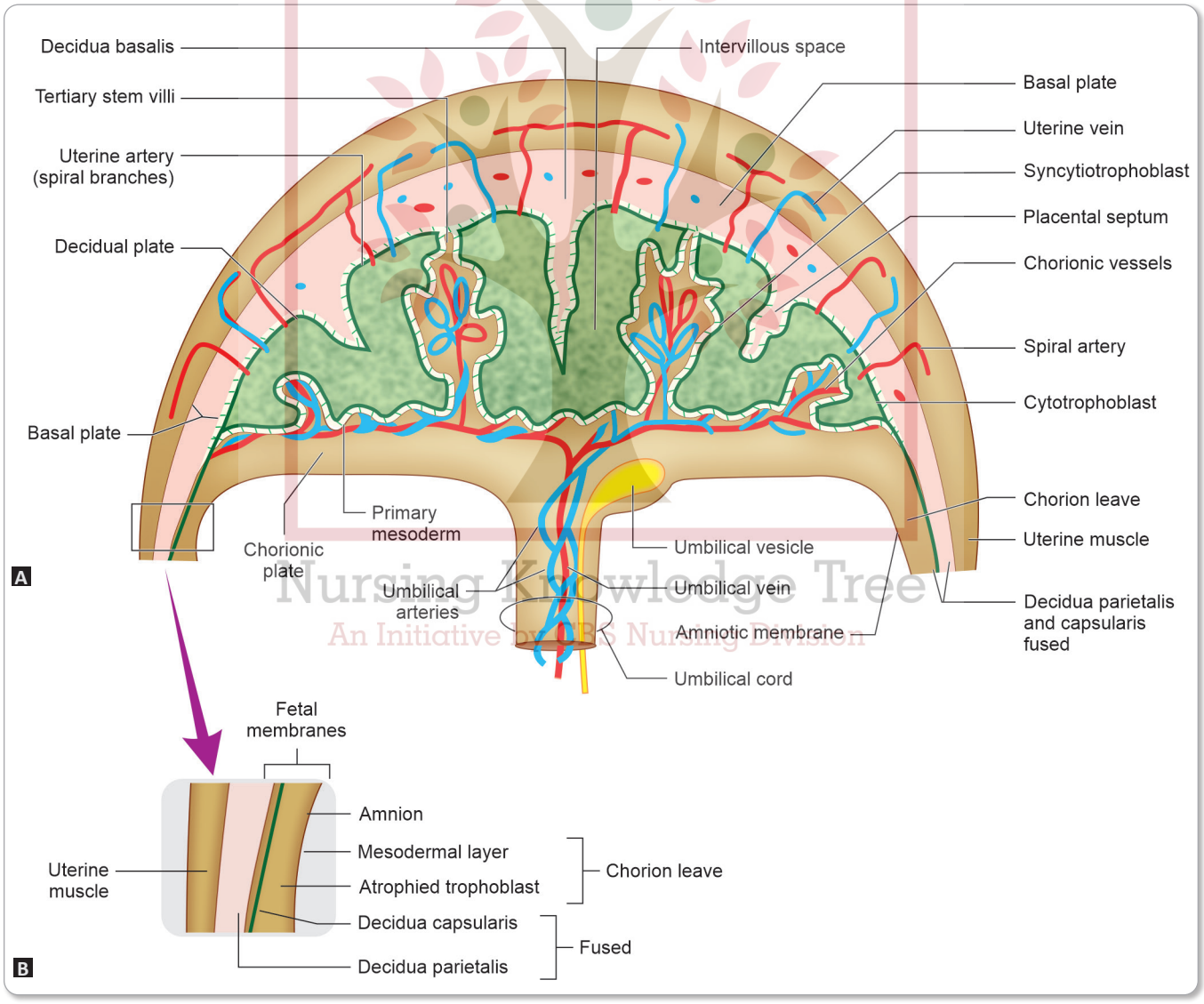
- The human placenta is:
  - **Discoid:** Because of the shape.
  - **Hemochorial:** Because of direct contact of the chorion with the maternal blood.
  - **Deciduate:** Because of connection between the mother and fetus through the umbilical cord
- **Sources:** Placenta is developed from following sources:
  - **Fetal component** develops from the chorion frondosum.
  - **Maternal component** consists of decidua basalis.
- On 11th day when the interstitial implantation is completed, the blastocyst is surrounded on all sides by lacunar spaces around cords of syncytial cells, called trabeculae.
- On 13th day, the stem villi develop from the trabeculae which connect the chorionic plate with the basal plate.
- Primary, secondary and tertiary villi are successively developed from the stem villi.
- **Arterio-capillary-venous system in the mesenchymal core of each villus is completed on 21st day.** This ultimately makes connection with the intraembryonic vascular systems through the body walls.
- Simultaneously, lacunar spaces become confluent with one another and by 3rd–4th week, form a multilocular receptacle lined by syncytium and filled with maternal blood.
- This space becomes the future intervillous space.

- As the growth of the embryo proceeds, decidua capsularis becomes thinner beginning at 6th week and both the villi and the lacunar spaces in the abembryonic area get obliterated. This is compensated by:
  - Exuberant growth and proliferation of the decidua basalis.
  - Enormous and exuberant division and subdivision of the chorionic villi in the embryonic pole (chorion frondosum).
- **These two, i.e., chorion frondosum and the decidua basalis form the discrete placenta. It begins at 6th week and is completed by 12th week.**
- Until the end of 16th week, the placenta grows both in thickness and circumference due to growth of the chorionic villi with accompanying expansion of the intervillous space. Subsequently, there is little increase in thickness but it increases circumferentially till term.

Structure of Placenta

Placenta is a disk-like spongy fleshy structure, thick at center and thin at edges. Fully developed placenta (at term) is reddish in color. It is formed from the layers of blastocyst (Figs 5.12A and B).

- **Average weight of placenta:** 500 g (approximately 1/6th of fetal weight).
- **Diameter:** 15–20 cm.
- **Thickness:** 2–2.5 cm at center thinning towards periphery.



Figs 5.12A and B: **A.** Structure of placenta; **B.** Layers of placental wall

- The umbilical cord is attached to the center of fetal surface of the placenta.
- **Diameter of cord:** 1–2.5 cm.
- **Length:** 30–100 cm (average).
- Covering of cord from outside to inside are amnion, mucoid embryonic connective tissue and Wharton's jelly.
- **Blood vessels:** 2 arteries +1 vein.

Placental Surfaces

- **Fetal surface:** It is smooth, shiny, transparent, and umbilical cord is attached at or near the center. Branches of umbilical vessels can be seen on this surface, radiating from umbilical cord. The underlying chorion can be seen through glistening amniotic membrane. Amniotic membrane can be peeled off from underlying chorionic plate except at umbilical cord.
- **Maternal surface:** It looks dull red in color and surface is divided into 15–30 cotyledons, separated by sulci. Small calcified white infarcts can be seen on the maternal surface.

Functions of Placenta

The placenta truly is an organ of life with a number of functions to protect the fetus. Its functions include:

- **Respiration:** Fetus obtains oxygen and excretes CO_2 through the placenta. Oxygen from the mother's body passes into the fetal blood by simple diffusion and similarly fetus gives off CO_2 into maternal blood.
- **Excretion:** Waste products from the fetus such as urea, uric acid and creatinine are excreted in the maternal blood by simple diffusion.
- **Storage:** The placenta stores glucose, iron and vitamins. Glucose stored in the form of glycogen gets reconverted to glucose when required (glycogenolysis).
- **Nutrition:** The fetus requires all the nutrients. Amino acids, glucose, vitamins, minerals, lipids, water and electrolyte are transferred across the placental membrane. Food from the maternal diet gets broken down into simpler forms by the time it reaches the placental site. The placenta selects those substances required by the fetus. It can breakdown complex nutrients into compounds that can be used by the fetus. Proteins get transferred as amino acids; carbohydrates as glucose and fats as fatty acids.
- **Protection:** Fetal membrane has long been considered a protective barrier to the fetus against noxious agents circulating in the maternal blood. Certain antibodies, which the mother possesses are passed on to the fetus to provide immunity for the baby approximately for 3 months after birth. Maternal infections during pregnancy by virus (rubella, chicken pox, measles, mumps, poliomyelitis), bacteria (treponema pallidum, mycobacterium) or protozoa (malarial parasite, toxoplasma gondii) may cross the placental barrier and affect the fetus in utero. Similarly, certain drugs can also cross the placental barrier and may have deleterious effects on the fetus.
- **Enzymatic functions:** Diamine oxidase inactivates the circulatory precursor amines. Oxytocinase neutralizes the oxytocin; and phospholipase A^2 which synthesizes arachidonic acid.
- **Endocrine functions:** Placenta secretes the following four hormones:
  1. **Beta hCG:** Cytotrophoblastic layer of chorionic villi produces hCG.
  2. **Estrogens:** These are produced by placenta in large amount throughout the pregnancy. The estrogen production is an index of fetoplacental well-being also.
  3. **Progesterone:** It is produced in the syncytial layer of placenta in increasing quantities until immediately before the onset of labor, then its level falls gradually.
  4. **Human placental lactogen:** It is another hormone produced by placenta and is involved in lactogenic and metabolic processes in pregnancy.
- **Immunological functions:** The fetus and the placenta contain paternally determined antigens, which are foreign to the mother. In spite of this, there is no evidence of graft rejection. Placenta probably offers immunological protection against rejection.

LIQUOR AMNII (AMNIOTIC FLUID)

Amniotic fluid (liquor amnii) is faintly alkaline watery content of the amniotic sac, which allows growth and free movement of the fetus. It is the nourishing and protecting liquid contained by the amnion of pregnant women.

Volume

Amniotic fluid volume is related to gestational age. It is about 50 mL at 12 weeks; 400 mL at 20 weeks and 1 L at 36–38 weeks.

Thereafter it diminishes, till at term it measures about 600–800 mL. At post-term, reduction occurs to the extent of 200 mL at 43 weeks.

Physical Features

- Faintly alkaline with low specific gravity of 1.010
- In early pregnancy, it is colorless, but near term it becomes pale straw.
- Abnormal color of liquor is seen in the following cases:
  - **Green:** Meconium stained.
  - **Golden:** Rh incompatibility, due to hemolysis of fetal RBC.
  - **Green yellow (saffron):** Post maturity.
  - **Dark colored:** Concealed hemorrhage.
  - **Dark brown:** Intrauterine death.

Composition

In first half of pregnancy, the composition is identical to plasma. But in late pregnancy the composition is altered. It includes:

- Water 98–99%
- **Solid (1–2%):** The following are solid constituents:
  - **Organic:** Proteins, glucose, urea, uric acid, creatinine, lipids and hormones.
  - **Inorganic:** Sodium, chloride, potassium.
  - **Suspended particles:** Lanugo, epithelial cells, vernix caseosa, cast off amniotic cells.

Functions

During Pregnancy

- Acts as a shock absorber and protects fetus from injuries
- Maintains even temperature (hemostasis).
- Allows free movement of fetus within the uterus.

During Labor

- Helps in cervical dilatation.
- It guards against umbilical cord compression.
- Flushes the birth canal at the end of first stage of labor.
- It is aseptic and bactericidal action protects the fetus and prevents ascending infection to the uterine cavity.

Clinical Importance

- Gives information regarding maturity of fetu.
- Intra-amniotic instillation of chemicals is used as a method for induction of abortion.
- Excess or less volume of liquor amnii is assessed by amniotic fluid index (AFI).
- Rupture of membranes with drainage of liquor is a helpful method in induction of labor.

UMBILICAL CORD

The umbilical cord or funis forms the connecting link between the fetus and the placenta through which the fetal blood flows to and from the placenta. It extends from the fetal umbilicus to the fetal surface of the placenta (Fig. 5.13).

- It contains blood vessels: Two arteries and one vein.
- Umbilical cord is protected by gelatinous substance called Wharton's jelly, which is formed from mesoderm.
- It is developed from body stalk of the mesodermal tissue stretching between embryonic disk and chorion.

Structure

The cord is bluish white in color and is about 40 cm in length with usual variation of 30–100 cm. Average diameter is 1.5 cm. The cord is twisted spirally and in some cases may be wrapped around neck or body of the fetus. There can be swelling at some places due to collection of Wharton's jelly called false knots.

Function

Umbilical cord acts as a lifeline between placenta and fetus by providing oxygen and nutrients to fetus and disposing the fetal waste products.

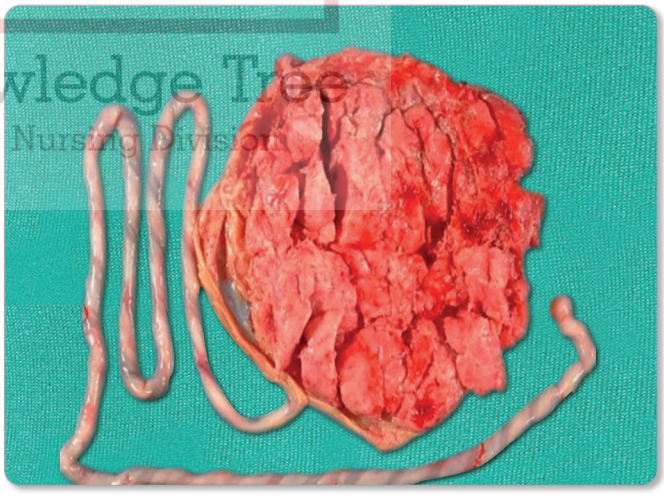


Fig. 5.13: Umbilical cord

FETAL SKULL

The fetal skull is ovoid in shape. At term, it is larger in proportion to other parts of the skeleton.

Regions of Fetal Skull

- **Vertex:** It is quadrilateral area bounded by the anterior fontanel and coronal suture in front, the posterior fontanel and lambdoidal suture behind and longitudinal lines passing through the parietal eminences laterally.
- **Brow or sinciput:** It is the area bounded by the supraorbital ridges in front, the anterior fontanel and coronal sutures behind and longitudinal lines passing through the frontal eminences laterally.
- **Face:** It is the area bounded by orbital ridges and root of the nose to the junction of chin and neck.

Bones of Fetal Skull

Figure 5.14A shows the bones of fetal skull.

- Two frontal bones
- Two parietal bones
- Two temporal bones
- One occipital bone

Sutures of Fetal Skull

The joint where two skull bones meet is called a suture. There are four sutures of obstetrical importance.

1. **Frontal suture:** Between two frontal bones.
2. **Sagittal suture:** Between two parietal bones.
3. **Coronal suture:** Between the frontal bone on one side and the parietal bones on other side.
4. **Lambdoidal suture:** Between the parietal and occipital bones.

Importance of Sutures

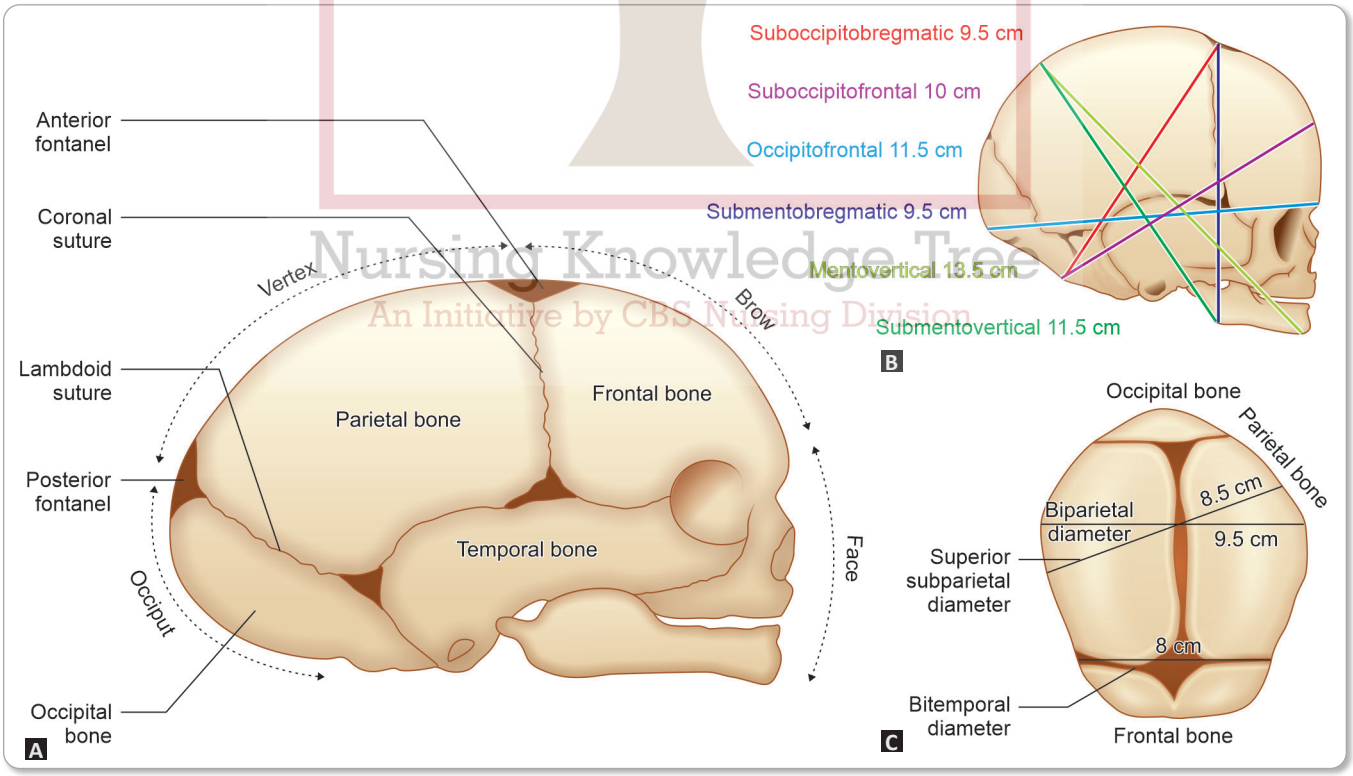
- Permits gliding movement of one bone over other during molding of head.
- Digital palpation of sagittal suture during vaginal examination in labor gives idea of engagement of head, degree of internal rotation of head and degree of molding of head.

Molding

Shaping of the fetal head to adapt itself to the dimensions of the birth canal during its descent through the pelvis.

Or

Overlapping of fetal skull bone when the fetus passes through the birth canal.



Figs 5.14A to C: **A.** Bones of fetal skull; **B.** Anteroposterior diameters of fetal skull; **C.** Transverse diameters of fetal skull

To identify molding, first palpate the suture lines on the fetal head and appreciate whether the following conditions apply. The skull bones that are most likely to overlap are the parietal bones, which are joined by the sagittal suture, and have the anterior and posterior fontanels to the front and back.

- **Sutures apposed:** This is when adjacent skull bones are touching each other, but are not overlapping. This is called degree 1 molding (+1).
- **Sutures overlapped but reducible:** This is when an examiner feels that one skull bone is overlapping another, but when the examiner gently pushes the overlapped bone, it goes back easily. This is called degree 2 molding (+2).
- **Sutures overlapped and not reducible:** This is when an examiner feels that one skull bone is overlapping another, but when the examiner tries to push the overlapped bone, it does not go back. This is called degree 3 molding (+3). If the examiner finds +3 molding with poor progress of labor, this may indicate that the labor is at increased risk of becoming obstructed.

Note:
Midwife needs to refer the mother urgently to a health facility if she identifies signs of an obstructed labor.

While documenting the degree of molding on the partograph, use a scale from 0 (no molding) to +3, and write them in the row of boxes provided:

- **0:** Bones are separated and the sutures can be felt easily.
- **+1:** Bones are just touching each other.
- **+2:** Bones are overlapping but can be separated easily with pressure by examiner finger.
- **+3:** Bones are overlapping but cannot be separated easily with pressure by examiner finger.

Fontanels

The place where two or more sutures join is called fontanel. There are six fontanels on skull but only two are of obstetrical importance:

1. **Anterior fontanel:** It is the largest fontanel. It is the junction of sagittal, frontal and coronal sutures. It is diamond shaped with 2.5 cm length and 1.5 cm width. Pulsations of cerebral vessels can be felt through it. The fontanel closes by 18 months of age.
2. **Posterior fontanel:** This is located where the sagittal suture meets the lambdoidal suture. It is triangle shaped and measures about 1.2 cm × 1.2 cm and smaller than anterior fontanel. It closes by 6 weeks of age.

Importance of Fontanel

- Fontanel facilitates molding of head.
- Its palpation through internal examination denotes degree of flexion of head.
- It is membranous after birth, helps in accommodating marked brain growth.
- Depressed in dehydration, elevated in case of raised ICP.
- Helpful for collection of blood and exchange transfusion.
- Cerebrospinal fluid can be drawn through fontanels.

Diameters of Fetal Skull

Fetal skull has four transverse diameters and six anteroposterior diameters (Figs 5.14B and C).

- **Transverse diameters:** For memorizing transverse diameters, learn a mnemonic "Miss Tina So Pretty".

Mnemonic

Miss Tina So Pretty
- Miss = Bimastoid diameter
- Tina = Bitemporal diameter
- So = Super subparietal diameter
- Pretty = Biparietal diameter

i. **Bimastoid diameter (7.5 cm):** Distance between the tips of mastoid processes.
ii. **Bitemporal diameter (8 cm):** Distance between anteroinferior ends of coronal suture.
iii. **Super subparietal diameter (8.5 cm):** Extends from a point placed below one parietal eminence to a point placed above other parietal eminence of the opposite side.
iv. **Biparietal diameter (9.5 cm):** Distance between two parietal eminences.

- **Anterior-posterior diameter:**

i. **Suboccipito-bregmatic (9.5 cm):** It extends from the nape of neck to center of bregma.
ii. **Suboccipito–frontal (10 cm):** It starts from the nape of neck to the anterior end of anterior fontanel or center of sinciput.
iii. **Occipito-frontal (11.5 cm):** It extends from the occipital eminence to the root of nose, i.e., up to Glabella.
iv. **Mento-vertical (14 cm):** It extends from midpoint of the chin to the highest point on the sagittal suture.
v. **Submento-vertical (11.5 cm):** It extends from the junction of floor of the mouth and neck to the highest point on the sagittal suture.

vi. **Submento-bregmatic (9.5 cm):** It extends from the junction of floor of mouth and neck to the center of the bregma.

FETAL CIRCULATION

During pregnancy, the fetal circulatory system works differently than after birth.

- The fetus is connected by the umbilical cord to the placenta. This is the organ that develops and implants in the mother's uterus during pregnancy.
- Through the blood vessels in the umbilical cord, the fetus gets all the needed nutrition and oxygen. The fetus gets life support from the mother through the placenta.
- Waste products and carbon dioxide from the fetus are sent back through the umbilical cord and placenta to the mother's circulation to be removed (Fig. 5.15).

Fetal Blood Circulation

Fetal blood circulation differs from adult circulation in several ways and is designed to ensure a high oxygen blood supply to the brain and myocardium.

Structure

Fetal blood circulation contains some unique structures:

- **Umbilical vein:** Carries oxygen and nutrients to the fetus.
- **Two umbilical arteries:** Carry deoxygenated blood and waste products from the fetus to the mother.
- **Ductus venosus (from a vein to a vein):** Shunts blood from the umbilical vein to the inferior vena cava, bypassing the liver and organs of digestion.
- **Foramen ovale (oval opening):** Shunts blood from the right atrium to the left atrium, bypassing the lungs.

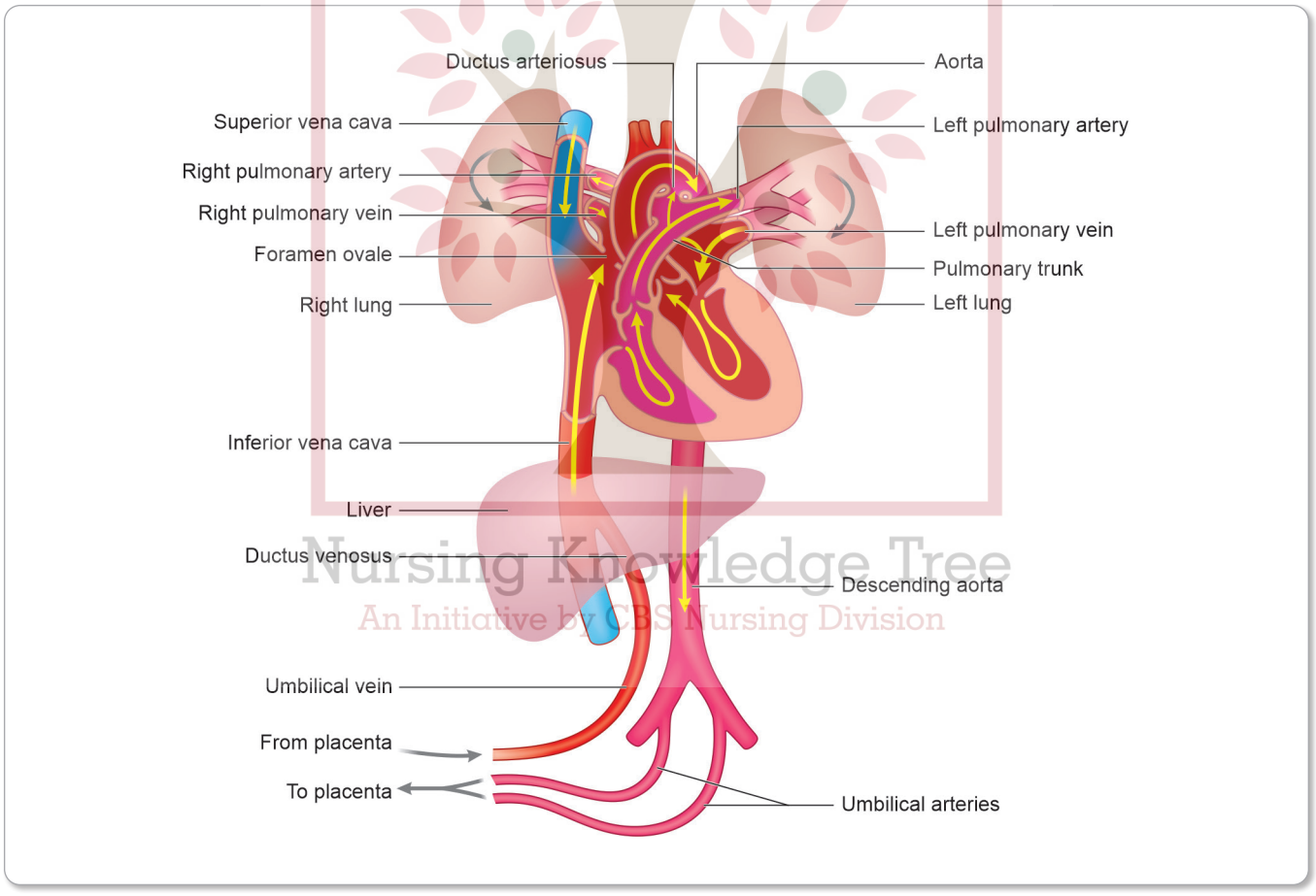


Fig. 5.15: Fetal circulation

- **Ductus arteriosus (from an artery to an artery):** Shunts blood from the pulmonary artery to the aorta, bypassing the lungs.
- **Hypogastric arteries:** Blood from descending aorta returns to the placenta through the two hypogastric arteries, which become umbilical arteries, when they enter the umbilical cord.

Pattern of Blood Flow

From the placenta, umbilical vein carries oxygenated blood then the oxygenated blood enters the inferior vena cava through the ductus venosus.

- In this way, most of the highly oxygenated blood goes directly into the right atrium, bypassing the liver.
- Through the foramen ovale, blood flows directly from the right atrium blood into the left atrium.
- From left atrium, blood flows into the left ventricle and then to aorta and through the subclavian arteries, to the cerebral and coronary arteries.
- In this way, brain and heart receive the highly oxygenated blood.
- Deoxygenated blood through the superior vena cava returns from head and arms, enters the right atrium and passes into the right ventricle.
- From right ventricle blood flows into pulmonary artery. Because fetal lungs are collapsed, most of the blood passes into the distal aorta through the ductus arteriosus. From the aorta, blood flows to the rest of the body (Fig. 5.16).

Changes in Blood Circulation after Birth

After the umbilical cord is clamped, the blood supply from maternal side is cut off and oxygenation takes place in the newborn's lungs. When the lungs expand with air, the pulmonary artery pressure decreases and circulation to lungs increases. Because of this, the following structural changes occur in the newborn vascular system:

- Closure of umbilical arteries
- Closure of ductus arteriosus
- Closure of the umbilical vein
- Closure of ductus venosus
- Closure of foramen ovale.

FETAL NUTRITION

Nutrition is one of the main factors that can affect fetal development, growth and health. During intrauterine life, determinants of fetal nutrition are quite different from those involved in postnatal nutrition. Fetus themselves cannot choose what to eat. The fetus is nourished through the umbilical cord; this "mix" is a result of maternal nutrition, metabolism, endocrinology and of placental perfusion and function.

Moreover, many factors influence fetal growth throughout pregnancy (Fig. 5.17). During this critical period, the nutritional and hormonal milieu may alter the expression of the fetal genome and this may have lifelong consequences. Perinatal growth, especially in the case of intrauterine growth restriction (IUGR), has pronounced effects on neonatal and adult health. Fetal nutrition is one of these factors. The complex interaction between genetic growth potential, the ability of the maternal–placental system to transfer nutrients to the fetus and the endocrine environment determines whether the fetus will follow its growth potential during intrauterine life.

While considering fetal nutrition, it is important to keep in mind that pregnancy represents a three-compartment model, with the mother, placenta and fetus each presenting its own metabolism while interacting with each other. Glucose, amino acids and fatty acids together with many micronutrients such as vitamins and ions are the most important nutrients in fetal life, both for tissue deposition and as fuel for oxidative purposes. There is considerable experimental evidence suggesting that in the second half of gestation, fetal growth is controlled by both maternal and placental factors.

Maternal Determinants

Maternal metabolism changes during pregnancy to supply the fetoplacental unit with all its nutritional needs. A mother's "adaptation to pregnancy" consists of a number of changes that affect metabolism as well as the function of the fetal placental unit through hemodilution, reduction of peripheral resistance to blood flow and reduction of blood pressure, most of all within the placental district, and hormonal changes.

Maternal nutrition and metabolism vary further during the course of pregnancy. The beginning of pregnancy is characterized by storing substances mainly within the adipose tissue. This is the period when the fetus is very small but developing its organs and the quality of the substrates obtained from the maternal circulation prevails over quantity. During the second part of gestation, the fetus grows at an exponential rate and completes the structure of important systems such as the central nervous system. Nutritional needs increase. It has been estimated that in a term fetus, 40–50 kcal/kg/day is utilized for tissue deposition, while 50 kcal/kg/day serves oxidative purposes.

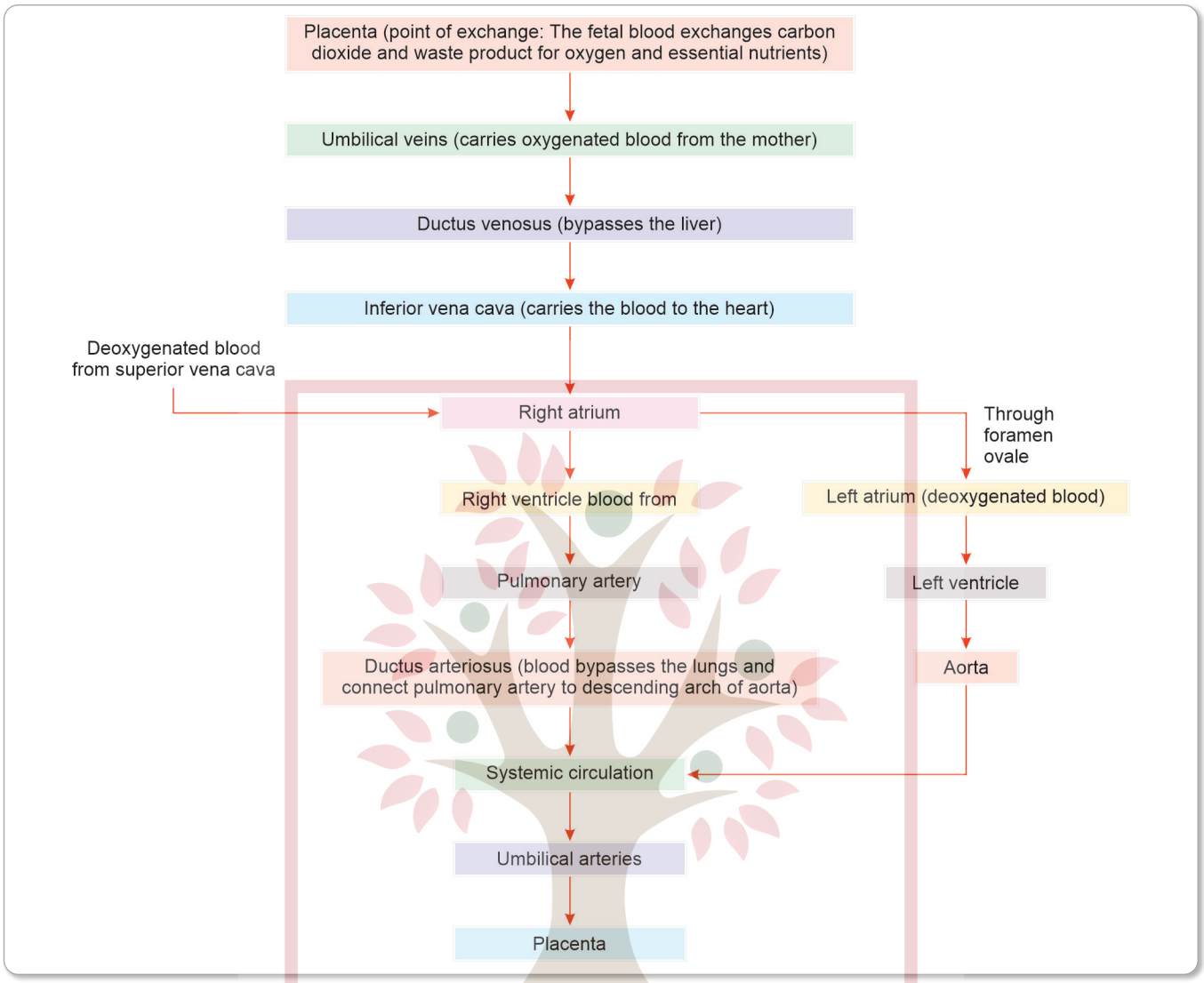


Fig. 5.16: Fetal blood circulation

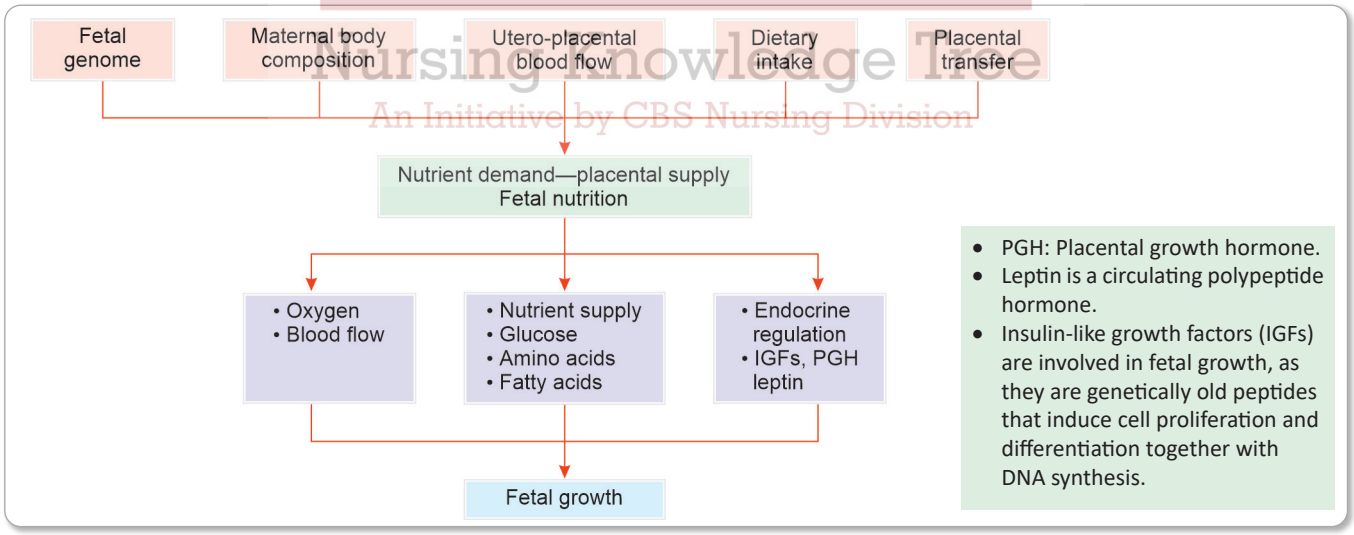


Fig. 5.17: Main determinants of fetal nutrition and growth

The mother adapts her metabolism in order to support the continuous draining of substrates by the fetoplacental unit. All the stores prepared at the beginning of pregnancy are mobilized with this aim, persist in the circulation for longer periods, and accomplish a faster metabolism to make the trans-placental passage easier. There is a marked increase in blood glycerol, free fatty acids and keto acids induced by fasting, even of a moderate degree, and this phenomenon is known as "accelerated starvation of pregnancy".

Research evidence shows that maternal nutrition may have long-term effects in increasing the risk of diseases in adult life, and that the effects are different depending on the gestational age of occurrence. Moreover, pregnancy is a period of rapid growth and cell differentiation, when both the mother and the fetus are very susceptible to alterations in the dietary supply of nutrients. Maternal metabolism should offer to the fetus a precise balance of substrates, at the right time, according to different stages of development.

Placental Function

Nutrients are transferred to the fetus by the placenta through complex mechanisms involving transport systems present on the trophoblast microvillous and basal membranes and on the endothelial membranes of fetal capillaries. Moreover, extensive placental metabolism has been demonstrated. Although the maternal concentration is the main determinant of fetal glucose, amino acid and fatty acid concentrations, the placenta acts to determine the composition of the fetal diet.

- A facilitated diffusion system is responsible for maternal-to-fetal transfer of glucose.
- Placental amino acid transporters are protein complexes within the maternal and fetal facing plasma membranes.
- The microvillous membrane (MVM) has several transport systems, and transports neutral amino acids such as alanine, serine, proline and glycine.
- There are also sodium-independent transport systems that transport branched-chain amino acids and phenyl alanine and lysine.
- The placenta transports long-chain polyunsaturated fatty acids to the fetus. Cellular uptake and intra-cellular translocation of non-esterified fatty acids have been facilitated by various membrane-associated and cytoplasmic proteins. Although all fatty acids can cross lipid bilayers by simple diffusion, a number of fatty acid-binding proteins (FABPs) allow bidirectional flux of fatty acids into and out of cells. Essential fatty acids are mainly transported to the placenta by non-esterified fatty acids carried by triglycerides from the maternal adipose tissue and liver and released by way of lipoprotein lipase.

Placental function varies through pregnancy so that while at mid-gestation, the placenta utilizes half of its oxygen and glucose uptake and transfers the rest to the fetal circulation; the proportion transferred to the fetus increases with the progress of gestation. In part, these changes are related to a large increase in the fetal/placental mass ratio during gestation. Moreover, functional maturation of the placenta occurs progressively through gestation, including significant increases in total placental surface area and decreased thickness, allowing increased nutrient transport to meet the needs of advancing fetal growth.

The adequacy of fetal nutrition is of utmost importance for fetal growth and wellness. Fetal nutrition is not comparable to adult nutrition because it is influenced by many factors including maternal diet, maternal metabolism, adaptation to pregnancy, and predisposition to pathologies that could affect normal placental development.

SUMMARY

- At 10 weeks, the fetal period begins and embryo is considered a fetus.
- The fetus is nourished through the umbilical cord.
- Fetal skull is ovoid in shape. There are three areas in fetal skull – (1) Vertex, (2) Brow, (3) Face.
- The joint where two skull bones meet is called a suture; its types are frontal suture, sagittal suture, coronal suture, lambdoidal suture.
- Overlapping of fetal skull bone when the fetus passes through the birth canal is called molding.
- Where two or more suture joins is called fontanel—six fontanels on skull but only two are of obstetrical importance and these are anterior fontanel and posterior fontanel.

FURTHER READINGS

- DC Dutta "Textbook of Obstetrics" 10th edition, Jaypee Publishers.
- https://doh.sd.gov/media/bnemplje/fetal.pdf
- Myles "Textbook for Midwives" 15th edition, Elsevier Publishers.

STUDENT ASSIGNMENT

LONG ANSWER QUESTIONS

1. Discuss in detail the fetal circulation.
2. Describe fetal growth and development in detail.

SHORT ANSWER QUESTIONS

1. What ae the regions of fetal skull?
2. What are the abnormalities of the cord?
3. Define embryology.

MULTIPLE CHOICE QUESTIONS

1. **Which of the following statements about the umbilical cord is correct?**
   a. The umbilical cord contains two arteries and one vein.
   b. Velamentous placenta occurs when the umbilical cord is attached to the margin of the placenta.
   c. A short cord is defined as a cord >100 cm.
   d. False knots in the umbilical cord are caused by a real knot interfering with circulation.
2. **What is the function of amniotic fluid during labor?**
   a. Helps in the formation of the fetal skull
   b. Provides nutrients to the fetus
   c. Aids in cervical dilatation
   d. Protects the placenta from infections
3. **Which hormone is primarily responsible for maintaining pregnancy and is produced by the syncytial layer of the placenta?**
   a. Human chorionic gonadotropin (hCG)
   b. Estrogen
   c. Progesterone
   d. Human placental lactogen (hPL)
4. **What is the function of the placenta during pregnancy?**
   a. Provides mechanical support to the fetus
   b. Facilitates exchange of gases and nutrients between the mother and fetus
   c. Secretes insulin to regulate blood sugar levels in the fetus
   d. Produces antibodies to protect the fetus from infections
5. **Which of the following statements about fetal development is correct?**
   a. Limb buds begin to appear at 8 weeks gestational age.
   b. Eyelids fuse together at 10 weeks gestational age.
   c. Fetal heartbeat can be detected electronically at 14 weeks gestational age.
   d. The fetus shows distinct human appearance at 6 weeks gestational age.

ANSWER KEY

1. a **2.** c **3.** c **4.** b **5.** c

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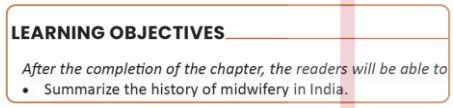
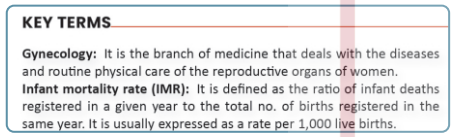
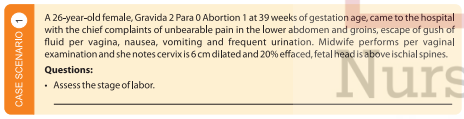
Learning Objectives in the beginning of every Chapter help readers understand the purpose of the chapter.



Chapter Outline gives a glimpse of the content covered in the entire chapter.

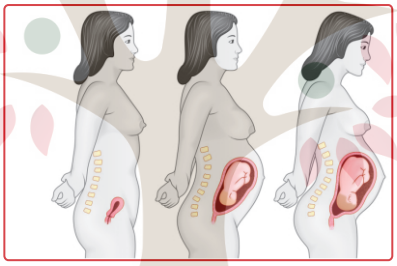
Key Terms are added in each chapter to help Students understand difficult scientific terms in easy language.



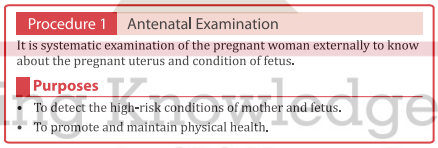


OSCE station is covered in a separate section to give extra edge to book from the practical point of view.

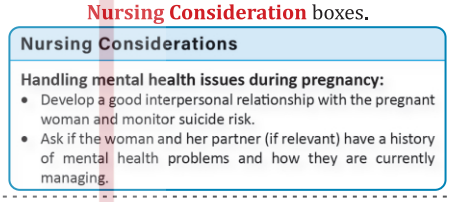
The book is well-illustrated with relevant colorful **Figures, Tables, Flowcharts,** etc.



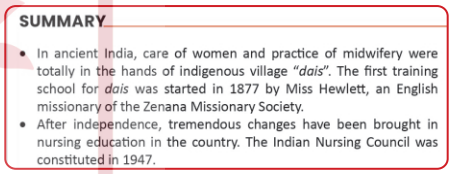
Obstetrics and Gynecological Nursing Procedures covered in a seprate section



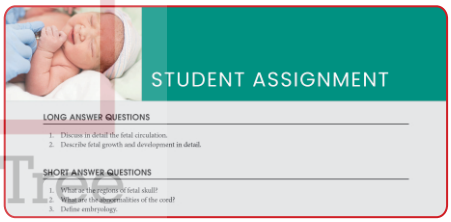
Clinical correlations from nursing point of view have been covered under **Nursing Consideration** boxes.



Each and every chapter ends with **Summary** for quick glance of the chapter.



At the end of chapters, **Student Assignment** section is given which contains frequently asked questions in exams and multiple choice questions to help students attain mastery over the subject.



About the Author

Sandeep Kaur MSc, PhD (N), (Obstetrics and Gynecology Nursing), is currently working as Professor cum HOD at Khalsa College of Nursing, Amritsar, Punjab. She has been teaching Obstetrics and Gynecology Nursing to undergraduate and postgraduate students for more than a decade. She has published nearly 20 research papers and review articles relating to different topics of obstetrics and gynecology in several national and international journals of repute. The author has participated and presented several research papers in various national and international workshops and conferences. She received the best paper presentation award in 2014. In 2021, the author received best Researcher Award and subsequently, in 2023, she bagged best Scientific Poster Presentation award.

Apart from this, she has supervised many BSc (N) and MSc (N) students. She is an active life member of various professional associations. She takes it as a matter of pride to shoulder any responsibility in the interest of nursing profession. As an academician, she has vast practical knowledge and she is well aware of the requirements of nursing students.

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