

CHAPTER 3

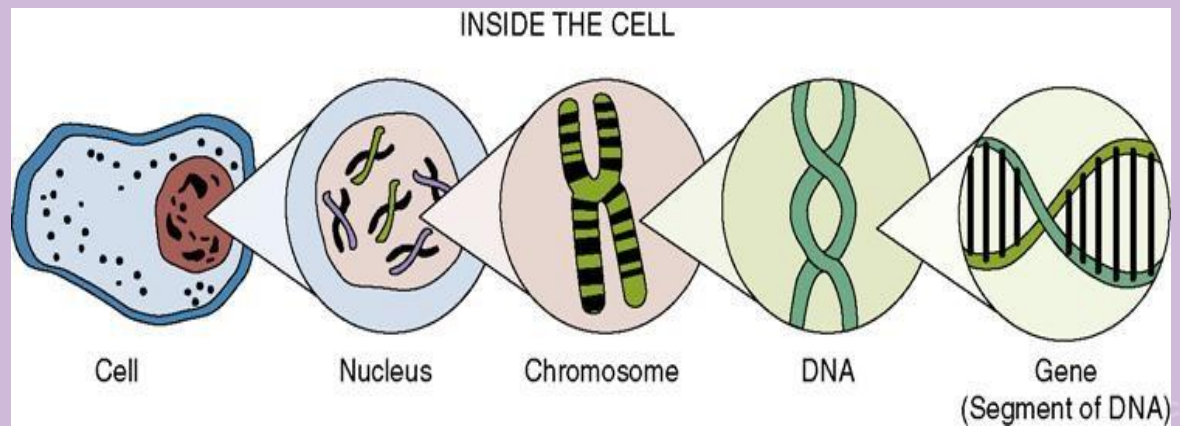
Fetal Development

Week 1 to Week 40



Body Cell

- DNA and nucleus control cell function
 - The genes and chromosomes in the DNA determine individual traits
- Each contains 46 chromosomes
 - 22 pairs of autosomes
 - 1 pair of sex chromosomes
- Biological development influenced by
 - External environment (teratogens)
 - Drug use
 - Undernutrition
 - Smoking



Cell Division and Gametogenesis

- Mitosis
 - Continuous process
 - Body grows, develops, and dead cells are replaced
 - Each daughter cell contains same number of chromosomes as parent cell—called *diploid*
 - Process of mitosis for sperm is spermatogenesis
 - Process of mitosis for ovum is oogenesis



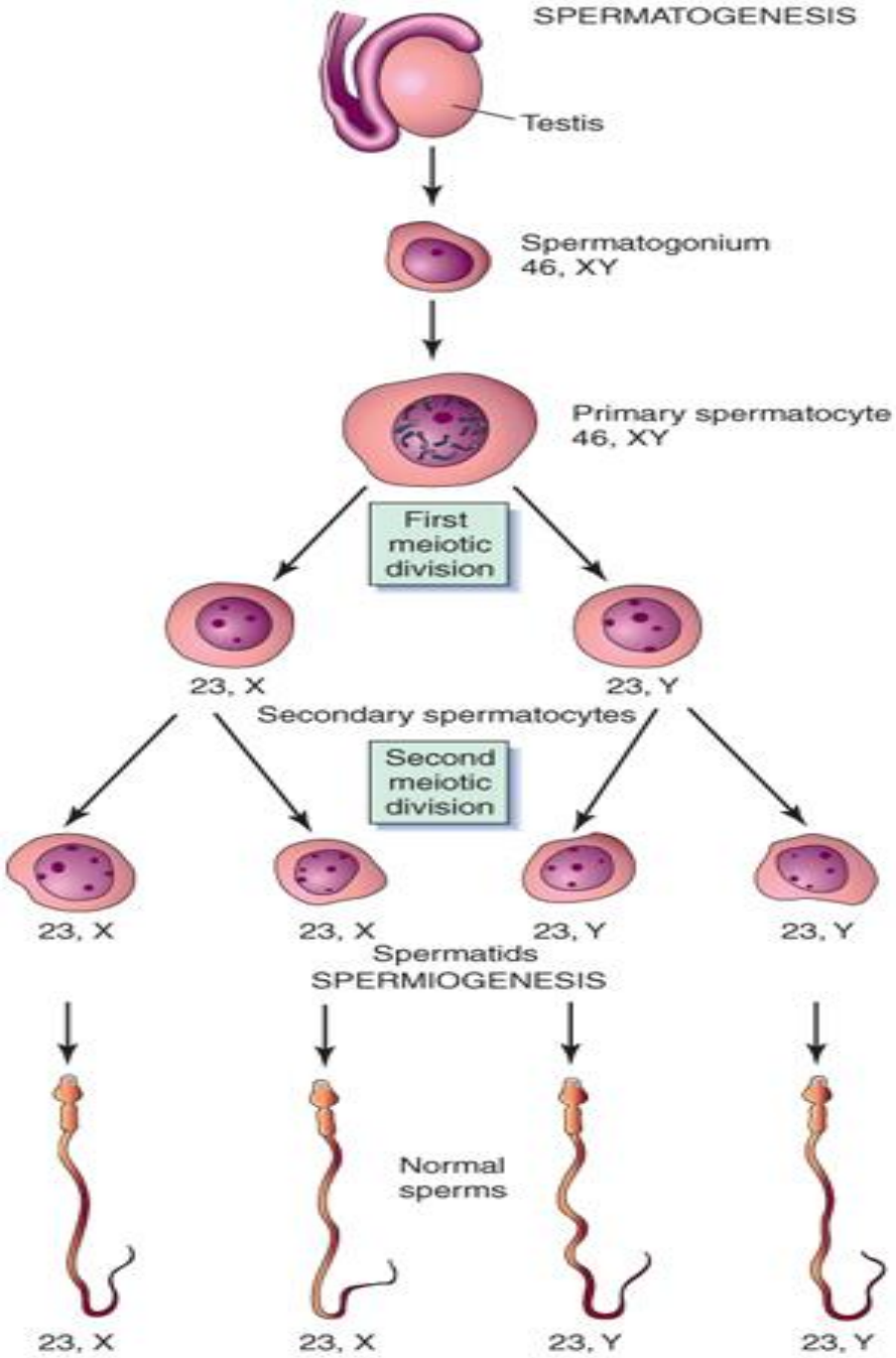
Cell Division and Gametogenesis

- Meiosis

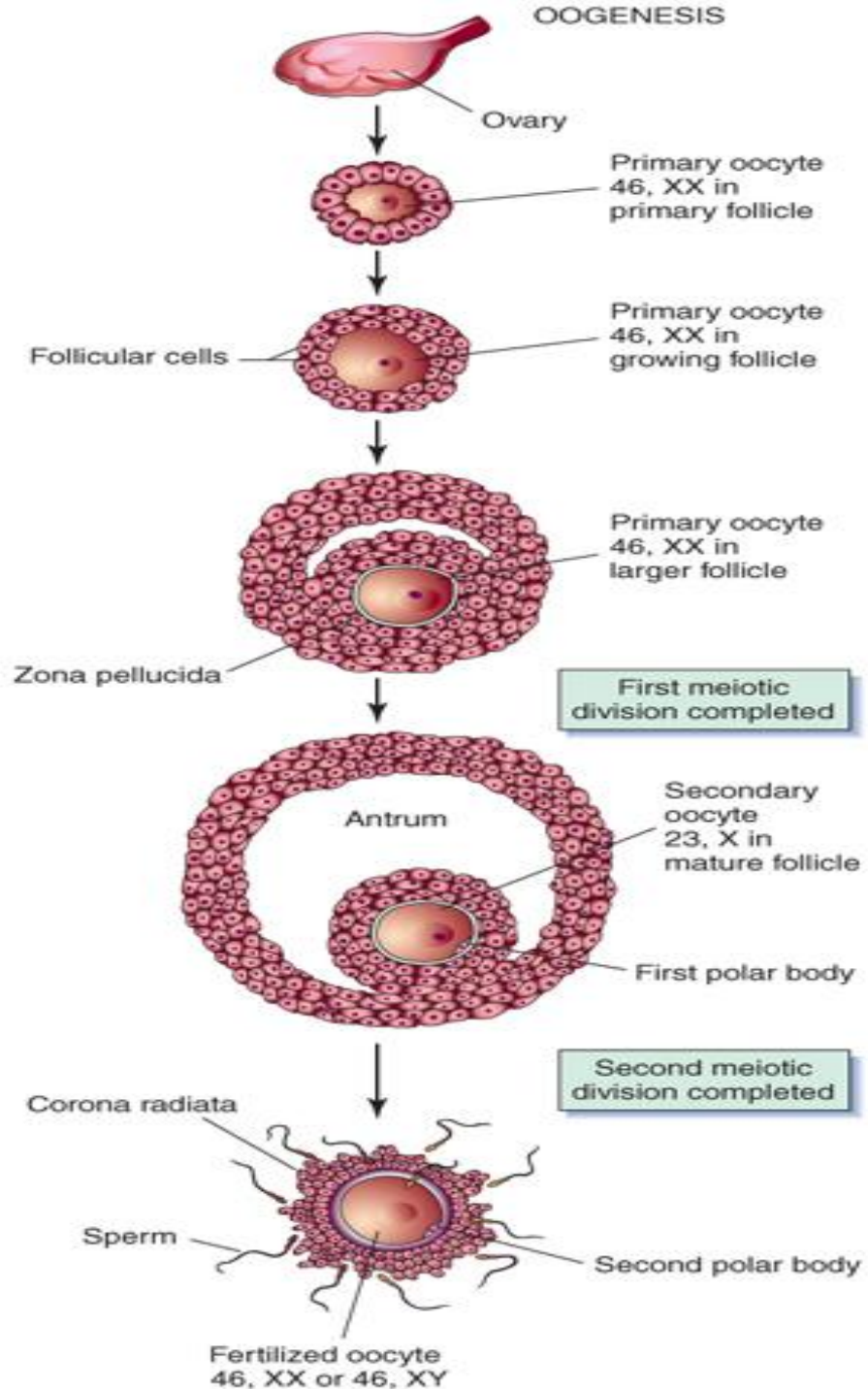
- Reproductive cells undergo two sequential divisions
- Number of chromosomes is 23 per cell with only one sex chromosome—called *haploid*
- At fertilization, the new cell contains 23 chromosomes from the sperm and 23 chromosomes from the ova
- Formation of gametes by this type of cell division is gametogenesis



SPERMATOGENESIS

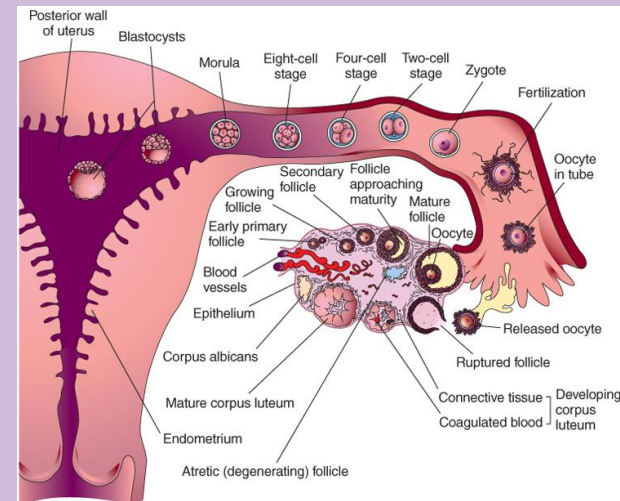


OOGENESIS



Fertilization

- Occurs when a sperm penetrates an ovum and they unite
- Takes place in the outer third of the fallopian tube, near the ovary
- As soon as it occurs, a chemical change in the membrane around the fertilized ovum prevents further sperm from penetrating the ovum



Nursing Tip

- During sexual counseling, the nurse should emphasize that the survival time of sperm ejaculated into the area of the cervix may be up to 5 days and that pregnancy can occur with intercourse as long as 5 days before ovulation



Sex Determination

- Sperm can carry either an X or a Y chromosome
- Male determines the gender of the fetus
- pH of female reproductive tract influences survival rate of the X- and Y-bearing sperm, including speed of motility
- XX results in female
- XY results in male



Sex Determination

- The gender of a baby is determined by the father's sperm.
- The conception and birth of a child of a certain sex is a source of concern to some families



Inheritance

- Each gene is coded for inheritance
 - Genes carry instruction for dominant and recessive traits
 - Dominant usually overpower recessive
 - Passed on to offspring

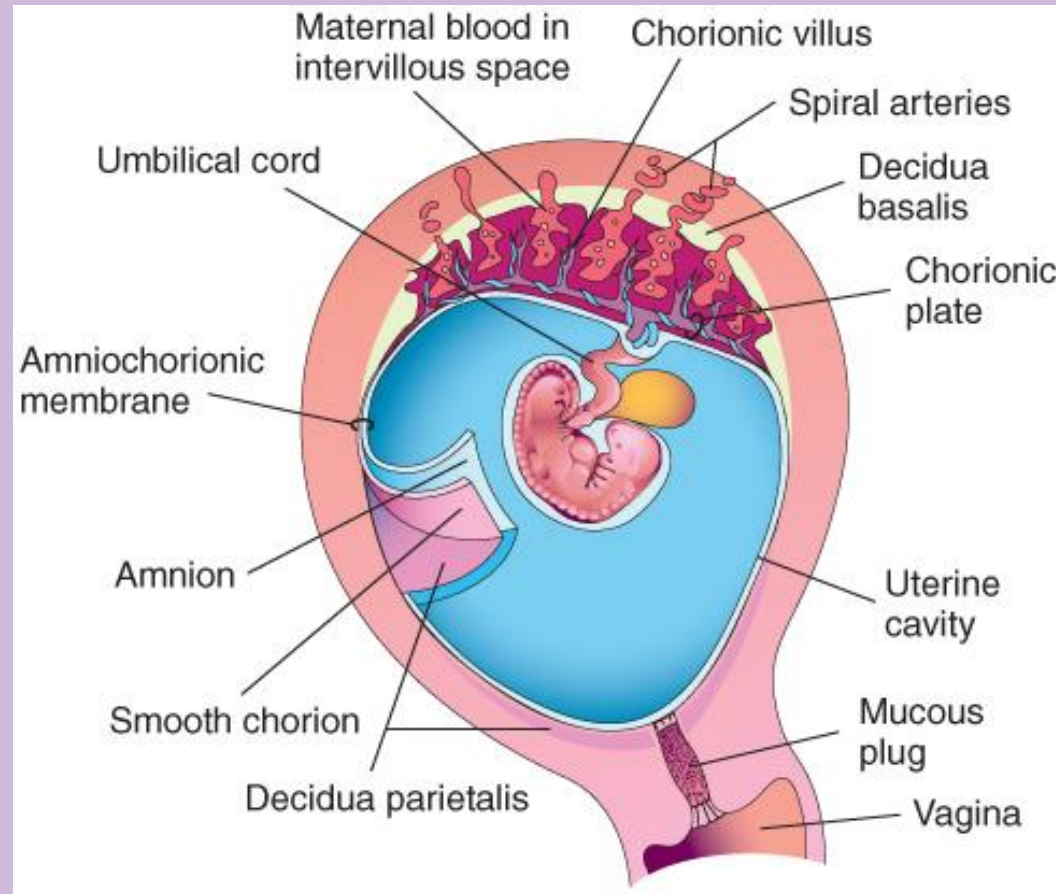


Tubal Transport of the Zygote

- Zygote is formed by union of sperm and ovum
- Transported through fallopian tube into uterus
- During transport, zygote undergoes rapid mitotic division (known as *cleavage*)
- Size of zygote does not increase, individual cells become smaller as they divide, then form a solid ball (known as a *morula*)



Maternal-Fetal Circulation



Morula

- Enters uterus on third day
 - Floats for another 2 to 4 days
 - Cells form a cavity
 - Two distinct layers evolve
 - Inner layer is a solid mass of cells called *blastocyst*
 - Develops into embryo and embryonic membranes
 - Outer layer—trophoblast
 - Develops into embryonic membrane—chorion



Implantation of the Zygote

- Usually in upper section of posterior uterine wall
 - Cells burrow into prepared lining—endometrium
 - Endometrium now called *decidua*
 - Area under blastocyst is decidua basalis
 - Becomes maternal part of the placenta



Development

- Cell differentiation
 - Occurs after implantation
 - Special functions
 - Chorion
 - Amnion
 - Yolk sac
 - Primary germ layers



Chorion

- Develops from trophoblast
- Envelops amnion, embryo, and yolk sac
- Thick membrane has projections called *villi*
- Villi extend into decidua basalis on uterine wall
- Form the embryonic/fetal portion of placenta



Amnion

- Second membrane
- Thin structure that envelops and protects embryo
- Together, chorion and amnion form an amniotic sac filled with fluid (bag of waters)
- Amniotic fluid is clear, mild odor, may contain bits of vernix or lanugo
- Volume of fluid steadily increases from ~30 mL at 10 weeks to 350 mL at 20 weeks; at 37 weeks, fluid is ~1000 mL



Functions of Amniotic Fluid

- Maintains an even temperature
- Prevents the amniotic sac from adhering to the fetal skin
- Allows symmetrical growth of fetus
- Allows buoyancy and fetal movement
- Acts as a cushion to protect the fetus and umbilical cord from injury



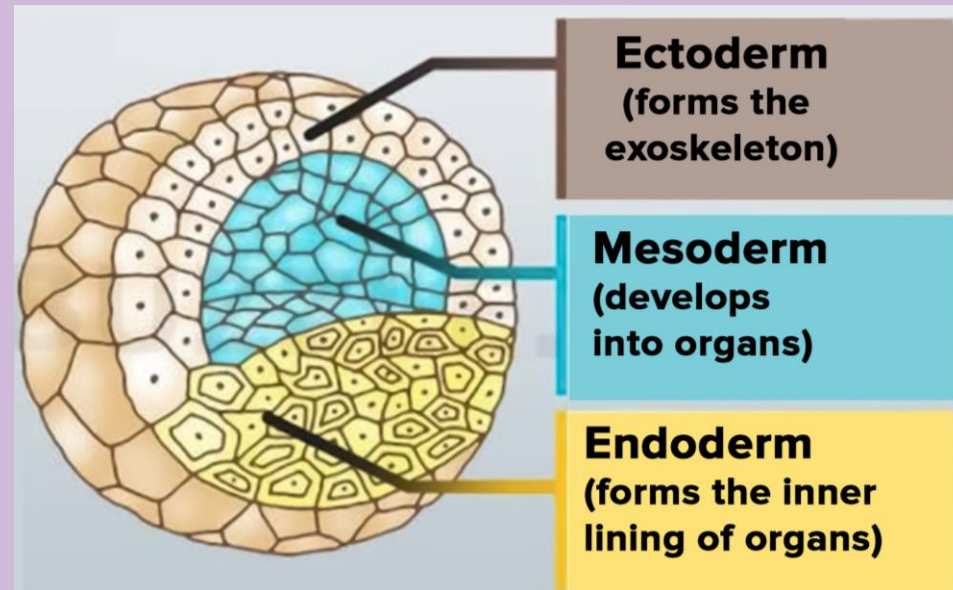
Yolk Sac

- A cavity develops on the ninth day after fertilization
- Functions only during embryonic life
- Initiates production of red blood cells
- Continues until fetal liver takes over around 6 weeks
- Umbilical cord encompasses yolk sac which then degenerates



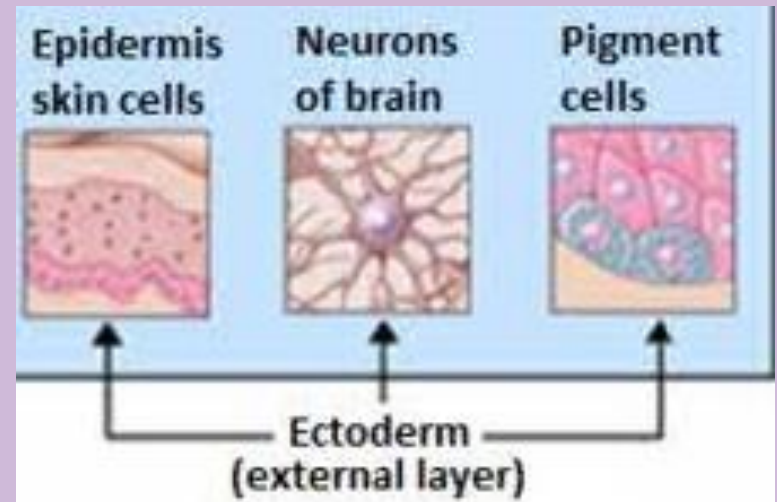
Germ Layers

- Zygote in blastocyst stage transforms into three primary germ layers
 - Ectoderm
 - Mesoderm
 - Endoderm



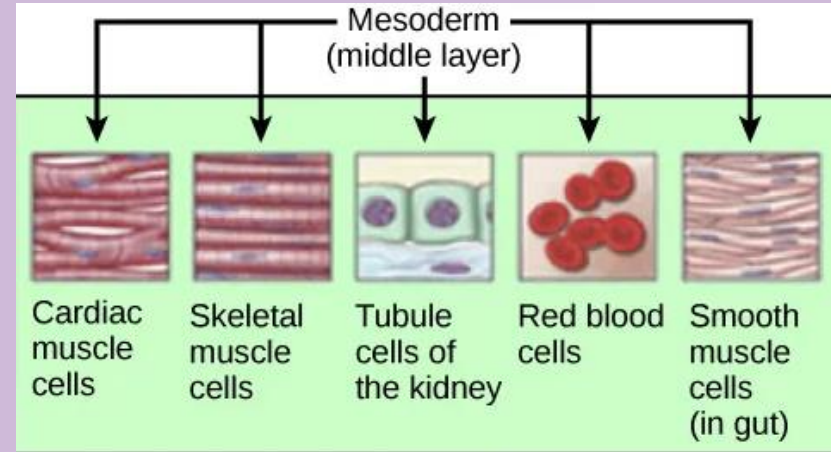
Ectoderm

- Outer layer of skin
- Oil glands and hair follicles of skin
- Nails and hair
- External sense organs
- Mucous membrane of mouth and anus



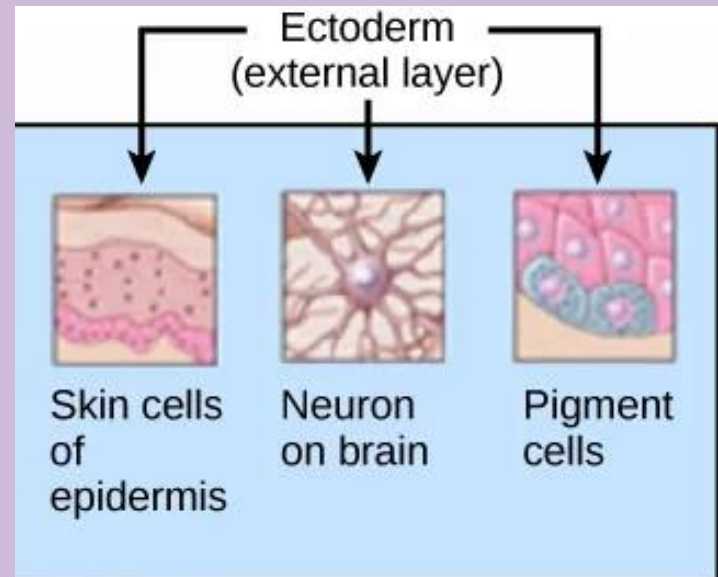
Mesoderm

- True skin
- Skeleton
- Bone and cartilage
- Connective tissue
- Muscles
- Blood and blood vessels
- Kidneys and gonads



Endoderm

- Lining of trachea, pharynx, and bronchi
- Lining of digestive tract
- Lining of bladder and urethra



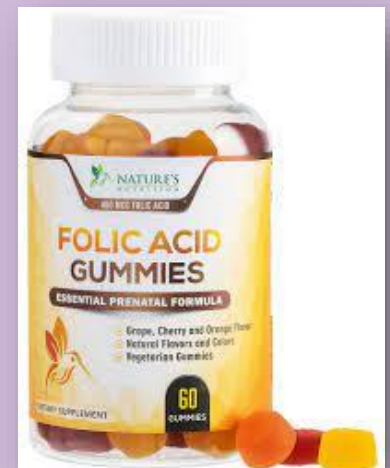
Three Stages of Prenatal Development

- Zygote: cell formed by union of sperm and ovum
- Embryo: second to eighth week of development
- By third week heart will pump blood
- Fetus: ninth week until birth
- Age of viability: 20 weeks of gestation but requires NICU care to survive



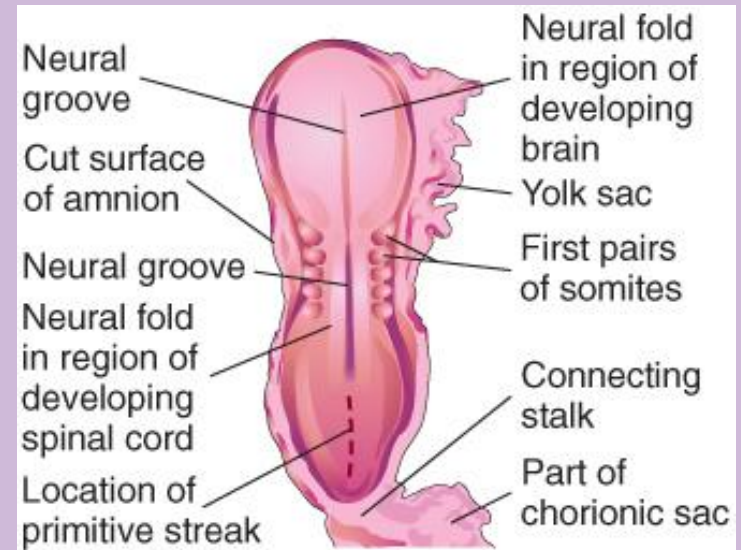
Nutritional Consideration

- Folic Acid Supplements can help prevent most neural tube defects..which can help with prevention of spina bifida
- It is important that mother start with supplements in the first days of the embryo.



Prenatal Development

- Embryo at 3, 4, 6, and 8 weeks and by 9th week able to see sex organs on Ultra sound



Prenatal Development

- Embryo at 17- leg movement and 25 weeks, bones ossified; eye movement occurs
- Embryo at 25 - eyes are open, now viable, vernix caseosa and lanugo on skin, brown fat formed, lungs begin to secrete surfactant



Prenatal Development

- Embryo at 29 and 36 weeks



Accessory Structures of Pregnancy

- Placenta
- Umbilical cord
- Fetal circulation
 - Supports fetus



Placenta

- Organ for fetal respiration, nutrition, and excretion
- Produces four hormones
 - Progesterone
 - Estrogen
 - Human chorionic gonadotropin (hCG)
 - Human placental lactogen (hPL)



Placental Transfer

- Fetal deoxygenated blood and waste products leave the fetus through two umbilical arteries
- Fetal and maternal blood do not normally mix
- Oxygenated, nutrient-rich blood from mother spurts into intervillous space from spiral arteries in the decidua
- Fetal blood releases carbon dioxide and waste products



Placental Transfer

- Fetal blood takes oxygen and nutrients before returning to fetus through umbilical vein
- Many harmful substances can be transferred to fetus
 - Drugs, nicotine, viral infectious agents
 - May cause fetal drug addiction, congenital anomalies, and fetal infection



Placental Hormones

- Progesterone
- Functions during pregnancy
 - Maintains uterine lining for implantation of the zygote
 - Reduces uterine contractions to prevent spontaneous abortion
 - Prepares the glands of the breasts for lactation
 - Stimulates testes to produce testosterone, which aids the male fetus in developing the reproductive tract



Placental Hormones

- Estrogen
- Stimulates uterine growth
 - Increases the blood flow to uterine vessels
 - Stimulates development of the breast ducts to prepare for lactation
- Effects of estrogen, not related to pregnancy
 - Increased skin pigmentation
 - Vascular changes in the skin and mucous membranes of nose and mouth
 - Increased salivation



Human Chorionic Gonadotropin (hCG)

- Causes the corpus luteum to persist and continue production of estrogen and progesterone to sustain pregnancy
- hCG is detectable in maternal blood as soon as implantation occurs (usually 7 to 9 days after fertilization)



Human Placental Lactogen (hPL)

- Also known as *human chorionic somatomammotropin* (hCS)
- hPL causes decreased insulin sensitivity and utilization of glucose by mother
 - Helps to make more glucose available to fetus to meet growth needs



Umbilical Cord

- Lifeline between mother and fetus
- Two arteries carry blood away from fetus
- One vein returns blood to the fetus
- Wharton's jelly covers and cushions cord vessels
- Normal length is 55 cm (22 inches)
- The umbilical cord usually protrudes near the center of the placenta

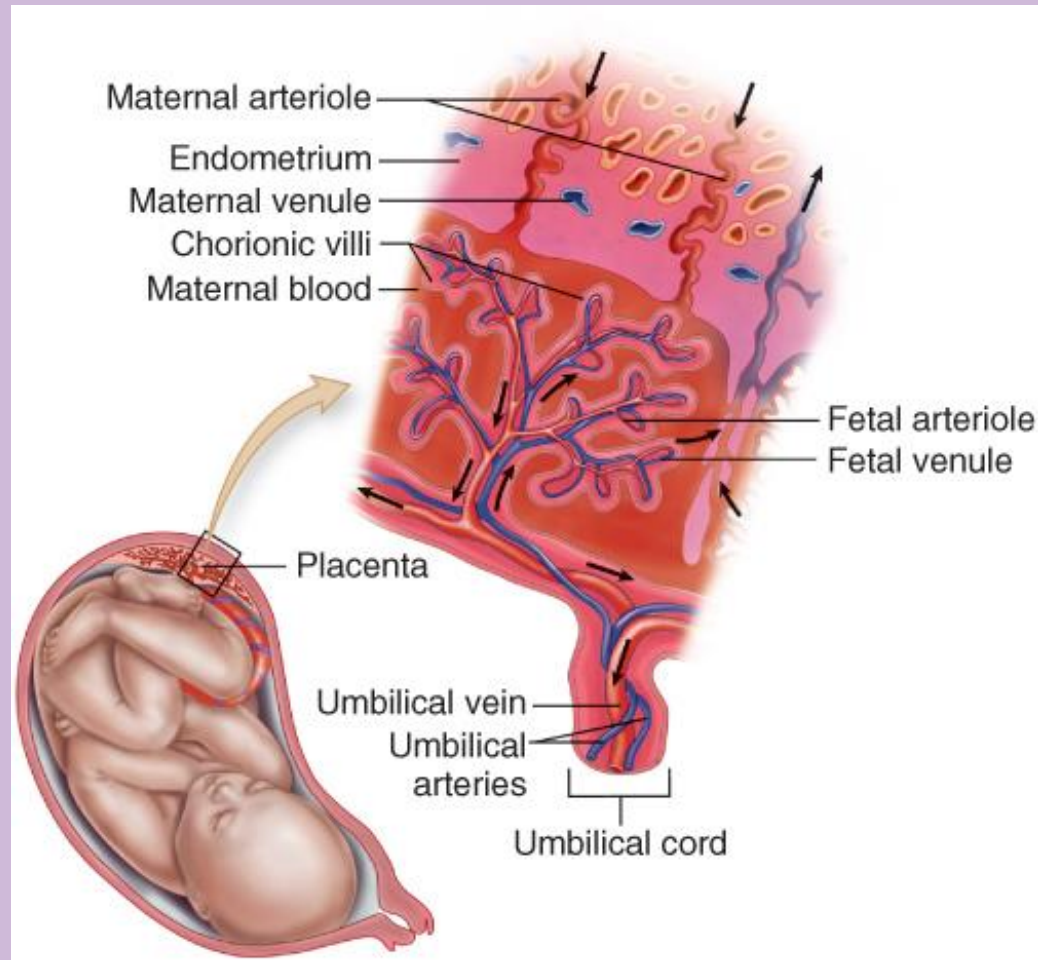


Memory Jogger

- An easy way to remember the number and type of umbilical cord vessels is the woman's name "AVA," which stands for "Artery-Vein-Artery"



Maternal-Fetal Circulation



Fetal Circulatory Shunts

- Foramen ovale-diverts most blood from right atrium to left atrium
- Ductus arteriosus-diverts most blood from the pulmonary artery into the aorta
- Ductus venosus-diverts some blood away from the liver as it returns from the placenta



Circulation Before Birth

- Blood enters fetal body through umbilical vein
- About half goes to the liver, remainder enters inferior vena cava through the ductus venosus, then goes through foramen ovale, then ductus arteriosus
- Blood containing waste products is returned to placenta through umbilical arteries



Circulation After Birth

- Foramen ovale closes within 2 hours after birth (permanently by age 3 months)
- Ductus arteriosus closes within 15 hours (permanently in about 3 weeks)
- Ductus venosus closes functionally when cord is cut (permanently in about 1 week)
- If newborn has untreated respiratory distress it can cause the foramen ovale to reopen the increased resistance to blood flow
- After permanent closure, the ductus arteriosus and ductus venosus become ligaments



Impaired Prenatal Development

- Undernutrition
 - Can result in permanent changes in fetal structure, physiology, and metabolism
 - Can influence development of conditions such as heart disease and stroke in adulthood
 - Exposure to toxins in utero
 - Can also influence health in later life



Impaired Prenatal Development

- Intrauterine growth restriction may reduce number of cells in organs
 - Can predispose to the development of specific diseases later in life
- Fetal growth best assessed when weight, length of gestation, placental size, and newborn head and abdominal circumference are considered
- Fetal growth limited by nutrients and oxygen received from mother-for instance monozygotic twins
- A healthy mother can produce a healthy child who is less prone to illness



Impaired Prenatal Development and Subsequent Illness

- Undernutrition in utero can result in:
 - Permanent changes in fetal structure, physiology, metabolism
 - Development of chronic conditions later in life
- To prevent illness of the next generation, this generation must focus on their own health practices



Multifetal Pregnancy

- Twins occur once in every 90 pregnancies
- When hormones are used to assist with ovulation, twinning and other multifetal pregnancies occur
- Monozygotic twins are from a single fertilized ovum (identical)
- Dizygotic twins are from two separate fertilized ovum (fraternal) so will have separate chorions
 - Usually a familial tendency⁴⁶



Multifetal Pregnancy

