Chapter 3

Fetal Development

Key Terms

- Viability
- Chorion
- Decidua
- Diploid
- Dizygotic
- Haploid
- Placenta
- teratogens

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 \textit{diploid}
Process of mitosis for sperm is spermatogenesis
Process of mitosis for ovum is oogenesis

\textbf{Meiosis}
Reproductive cells undergo two sequential divisions
Number of chromosomes is 23 per cell with only one sex chromosome—called \textit{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

\textbf{Cell Division and Gametogenesis (cont.)}
\textbf{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

\textbf{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

\textbf{Sex Determination}
Sperm can carry either an X or 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

\textbf{Sex Determination (cont.)}

- 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.

\textbf{Inheritance}
Each gene is coded for inheritance
Genes carry instruction for dominant and recessive traits
Dominant usually overpower recessive
Passed on to offspring

\textbf{Morula}
Enters uterus on third day
Floats for another 2 to 4 days
Cells forms a cavity
Two distinct layers evolve
Inner layer is a solid mass of cells called \textit{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 at about 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
Fetus: ninth week until birth
Age of viability: 20 weeks of gestation but requires NICU care to survive
Prenatal Development
Prenatal Development (cont.)
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 intervillus space from spiral arteries in the decidua
Fetal blood releases carbon dioxide and waste products
Placental Transfer (cont.)
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 (cont.)

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
Ductus arteriosus
Ductus venosus

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

Changes in 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)
  After permanent closure, the ductus arteriosus and ductus venosus become ligaments

Multifetal Pregnancy
Twins occur once in every 90 pregnancies
When hormones are used to assist with ovulation, twinning and other multifetal pregnancies occur
Monozygotic is from a single fertilized ovum (identical)
Dizygotic is from two separate fertilized ovum (fraternal)

Multifetal Pregnancy (cont.)