

Chapter 20 – Pregnancy, Growth, Development, and Genetics

20.1 Introduction

- A. Growth is an increase in size; development (which includes growth) is the continuous process by which an individual changes from one life phase to another.
- B. The life phases are the prenatal period, which begins at fertilization and ends at birth, and the postnatal period, which begins at birth and ends at death.

20.2 Pregnancy

- A. Pregnancy is the presence of developing offspring in the uterus, an event resulting from fertilization.
- B. Transport of Sex Cells (Fig. 20.1, 20.4a)
 - 1. Sperm cells must reach the upper one-third of the uterine tubes for fertilization to occur.
 - 2. Under the influence of estrogen during the first half of the menstrual cycle, uterine secretions are thin, allowing sperm cells to swim easily toward their destination.
- C. Fertilization (Fig. 20.2; Table 20.1)
 - 1. With the aid of the acrosomal enzyme, the sperm cells erode away the corona radiata and zona pellucida surrounding the secondary oocyte, and one sperm cell penetrates the egg cell membrane.
 - 2. When penetration occurs, changes in the egg cell membrane and zona pellucida prevent the entry of additional sperm cells.
 - 3. Fusion of egg and sperm nuclei completes fertilization.
 - 4. Fertilization results in a diploid zygote.

20.3 Prenatal Period

- A. Early Embryonic Development (Fig. 20.3-20.5)
 - 1. Cells undergo a period of mitosis called cleavage, when cells become smaller and smaller.
 - 2. The dividing mass of cells (morula) moves down the uterine tube to the uterus, where a stage called the blastocyst implants in the lining of the uterus.
 - 3. The offspring is called an embryo during the first eight weeks of development, and a fetus after that time.
 - 4. Some of the cells of the blastocyst become the placenta, which also secretes hormones.
- B. Hormonal Changes during Pregnancy (Figs 20.5-20.6; Table 20.2)
 - 1. The outer layer of cells (trophoblast) of the blastocyst stage secrete the hormone human chorionic gonadotropin (hCG), which maintains the corpus luteum and thus also maintains the uterine lining and the pregnancy.
 - 2. Levels of hCG remain high until the placenta can produce enough hormones on its own to maintain the pregnancy.
 - 3. The placenta also secretes placental lactogen for breast development and estrogens.
 - 4. Other hormonal changes during pregnancy include increased secretions of aldosterone (promotes fluid retention) and parathyroid hormone (to maintain a high calcium level in the blood).
- C. Embryonic Stage (Figs. 20.7-20.14; Table 20.3)
 - 1. The embryonic stage lasts from the second to the eighth week of development, during which time the placenta develops, and all the main internal organs and major external features appear.
 - 2. During the second week, the embryo is now called a gastrula and its inner cell mass transforms into the embryonic disk, and layers form within it.
 - 3. These layers become the three primary germ layers and give rise to all organ systems.

- a. Ectoderm gives rise to the nervous system, portions of special sensory organs, the epidermis and epidermal derivatives, and the linings of the mouth and anal canal.
 - b. Mesodermal cells form all types of muscle tissue, bone tissue, bone marrow, blood, blood and lymphatic vessels, internal reproductive organs, kidneys, and epithelial linings of the body cavities.
 - c. Endodermal cells produce the epithelial linings of the digestive tract, respiratory tract, urinary bladder, and urethra.
 4. As the embryo implants, the trophoblast sends out extensions that develop into chorionic villi.
 5. By the fourth week, the heart is beating, the head and jaws appear, and limb buds form.
 6. As the chorionic villi develop, exchanges of gases and nutrients occur through the placental membrane.
 7. By the eighth week, the trophoblast is now the chorion, a portion of which develops into the placenta.
 8. During this time, another membrane, the amnion, is developing around the embryo and will hold cushioning amniotic fluid.
 9. An umbilical cord containing two umbilical arteries and one vein forms.
 10. Two other membranes form in association with the embryo.
 - a. The yolk sac, formed during the second week, is the first site of blood cell formation and also gives rise to the stem cells of the immune system.
 - b. The allantois forms during the third week and joins the connecting stalk of the embryo; it forms blood cells and gives rise to the umbilical arteries and vein.
 11. By the beginning of the eighth week, the embryo is 30 millimeters in length and all essential body systems have formed.
- D. Fetal Stage (Fig. 20.14)
1. The fetal stage begins at the end of the eighth week of development and lasts until birth.
 2. During this period, growth is rapid and body proportions change considerably.
 3. Existing structures grow and mature and only a few new parts appear.
 4. The body enlarges, the limbs grow to the relative size they will maintain throughout development, and the bones ossify.
 5. During the fifth month, the mother may feel the fetus move, and lanugo (fine hair) and dead epithelial cells and sebum cover the skin.
 6. In the final trimester, brain cells form rapidly and organs grow and mature as the fetus greatly increases in size.
- E. Fetal Blood and Circulation (Fig. 20.15; Table 20.4)
1. Substances diffuse through the placental membrane and umbilical vessels carry them to and from the fetus; fetal blood has a greater oxygen-carrying capacity than maternal blood.
 2. The umbilical vein, transporting blood rich in oxygen and nutrients, enters the body and travels to the liver where half of the blood is carried into the liver and half bypasses the liver through the ductus venosus on its way to the inferior vena cava.
 3. A foramen ovale conveys a large portion of the blood entering the right atrium from the inferior vena cava, through the atrial septum, and into the left atrium, thus bypassing the lungs.
 4. A second lung bypass is the ductus arteriosus, which conducts some blood from the pulmonary trunk directly to the aorta.
 5. Umbilical arteries carry blood from the internal iliac arteries to the placenta, where

it can exchange wastes and again pick up nutrients and oxygen.

F. Birth Process (Fig. 20.16)

1. Pregnancy continues for thirty eight weeks and terminates in the birth process.
2. As the placenta ages, less progesterone is produced, which normally inhibits uterine contractions.
3. A decreasing progesterone concentration may stimulate the synthesis of prostaglandins, which may initiate labor.
4. Stretching uterine tissues stimulates the release of oxytocin from the posterior pituitary, which stimulates uterine contractions.
5. As the fetal head stretches the cervix, a positive feedback mechanism results in stronger and stronger uterine contractions and a greater release of oxytocin.
6. Positive feedback causes abdominal muscles to contract with greater force and the fetus is forced through the birth canal to the outside.
7. Following birth, the placenta is expelled by the continued uterine contractions (afterbirth).

20.4 Postnatal Period

A. Following birth, mother and newborn experience physiological and structural changes.

B. Milk Production and Secretion (Fig. 20.17)

1. Following childbirth, the action of prolactin is no longer inhibited and the mammary glands are stimulated to produce large quantities of milk.
2. First milk, or colostrum, is a watery fluid rich in proteins and antibodies.
3. Milk does not readily flow into the ductile system, but must be triggered to do so by a reflex involving the infant suckling at the breast, which triggers release of oxytocin from the posterior pituitary.
4. Human milk is the best possible food for human babies.

C. Neonatal Period (Fig. 20.18)

1. The neonatal period begins abruptly at birth and lasts for four weeks.
2. The first breath must be forceful to inflate the lungs for the first time.
 - a. Surfactant in a full-term newborn reduces surface tension.
3. At birth, the newborn must live off its fat stores for two to three days until the mother's milk comes in.
4. The newborn is susceptible to dehydration since the homeostatic mechanisms involving water conservation in the kidneys are not yet fully functioning.
5. A number of changes occur in the newborn's circulation: umbilical vessels constrict, the ductus venosus constricts, the foramen ovale closes, and the ductus arteriosus constricts.
 - a. Most of these circulatory changes are gradual and occur during the first fifteen minutes after birth, although it may take up to a year for the foramen ovale to close.

20.5 Aging

A. Passive Aging

1. Passive aging is the breakdown of structures and slowing of function.
2. Faulty genetic instructions due to biochemical abnormalities during cell division and the breakdown of lipids are present.
3. Highly reactive free radicals will kill cells by destabilizing adjacent molecules.

B. Active Aging

1. Begins prior to birth as certain cells die as a part of development. Cells continue to die throughout our lives so new, healthy cells may replace them.

20.6 Genetics (Figs. 20.19-20.20)

A. The field of genetics investigates how genes confer specific characteristics and how genes are passed from generation to generation

- B. Chromosomes and Genes Come in Pairs.
 - 1. Charts called karyotypes display the 23 chromosome pairs of a human somatic cell.
 - 2. Autosomes are pairs 1 through 22, and do not carry the genes that determine sex.
 - 3. The other two chromosomes, the X and the Y, determine sex and are called sex chromosomes.
 - 4. Alleles are copies of genes identical or slightly different.
 - 5. Identical alleles are homozygous. Two different alleles are heterozygous.
 - 6. A combination of alleles is one's genotype.
 - 7. The characteristic associated with a particular genotype is its' phenotype.
- C. Modes of Inheritance
 - 1. Patterns of inheritance through families are called modes of inheritance.
 - 2. Dominant and recessive traits
 - a. Three major modes of inheritance are autosomal recessive, autosomal dominant, and X-linked recessive.
 - b. A Punnett Square symbolizes the logic used to determine probabilities of genotypes in offspring.
 - c. A pedigree shows family members how they are related.
- D. Multifactorial Traits
 - 1. Most traits are influenced to some extent by environmental factors, such as nutrition, physical activity, and exposure to toxins.