LESSON ASSIGNMENT

LESSON 2

Embryology and Fetal Development.

TEXT ASSIGNMENT

Paragraphs 2-1 through 2-15.

LESSON OBJECTIVES

After completing this lesson, you should be able to:

2-1. Identify terms and definitions that are related to embryology and fetal development.

2-2. Identify the principles of fertilization.

2-3. Identify statements referring to the process of implantation.

2-4. Select statements concerning sex determination.

2-5. Select descriptive statements referring to placenta development.

2-6. Identify the functions of the placenta.

2-7. Identify statements referring to fetal membranes.

2-8. Identify fetal development at the end of each trimester.

2-9. Identify the normal duration of a pregnancy.

2-10. Select statements giving information about what is obtained by an amniocentesis.

2-11. Identify risks of an amniocentesis.

2-12. Identify components of fetal circulation.


2-14. Select six diseases from which the fetus received temporary protection.

2-15. Identify identical and fraternal twins.

SUGGESTION

After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.
LESSON 2

EMBRYOLOGY AND FETAL DEVELOPMENT

2-1. GENERAL

Pregnancy is a sequence of events that normally includes fertilization, implantation, embryonic growth, and fetal growth that terminates in birth (see figure 2-1). Even though there are many events that take place in the reproductive cycle, we cannot include every detail in this lesson. However, the following information will give descriptive events of what goes on in the uterus prior to birth. This information will also help you to recognize potential problems and to be able to intervene in the nursing care process.

2-2. PRINCIPLES OF FERTILIZATION (CONCEPTION)

a. Fertilization refers to the joining together of the ovum (egg) and sperm cells. The ovum originates in the graafian follicle within the ovary. The sperm cell originates in the testes. The microscopic union of sperm and ovum increase in size more than 20 billion times from conception to birth. See figure 2-2 for union of sperm and ovum.
b. During sexual intercourse, 2 to 5 ml of semen, usually containing more than 300 million sperm, is ejaculated into the female’s vagina. By flagellar (wiggly) movement, the sperm make their way through the fluids of the cervical mucous, across the endometrium, and into the fallopian tube to meet the descending ovum in the ampulla of the fallopian tube (see figure 2-3). Only one sperm is required for actual fertilization, but the presence of many increases the chances for one to penetrate. The union between ovum and sperm occurs in the outer third of the fallopian tube.
c. The combined ovum and sperm, referred to as the zygote, begins rapid cell division and in 2 to 3 days becomes a structure referred to as *morula*. The morula is a rapidly growing structure and reaches the uterus in approximately 4 days.

2-3. PROCESS OF IMPLANTATION

a. The morula floats in the uterus for 3 to 4 days, gaining in size and weight. At this time, the hollow fluid-filled morula, now called blastocyst burrows into the uterine lining.

b. The outer surface of the blastocyst becomes covered with finger-like projections called chorionic villi. Chorionic villi aid in the process of implantation into the endometrium (decidua). Villi also manufacture human chorionic gonadotropin (HCG) which signal the corpus luteum within the ovaries to continue production of progesterone and estrogen to prevent menstruation.

c. Implantation normally occurs in the upper, posterior wall of the uterus. The point of implantation becomes the origin for the placenta and umbilical cord.

**NOTE:** See figure 2-4 for associated events of fertilization and implantation.

![Diagram of fertilization and implantation]

2-4. Events of fertilization and implantation.
2-4. SEX DETERMINATION

Chromosomes are small, threadlike structures within each cell that contain genes, which carry genetic instructions. These genes control the physical and chemical traits inherited by children from their parents. The inherited traits are color of the eyes, sex, height, and skin color.

a. The **female** has 23 pairs of chromosomes. The pair of chromosomes that determined her sex are named "XX." The ovum carries one chromosome from each of the female’s pairs (23 chromosomes). The ovum can only carry an "X" sex chromosome.

b. The **male** has 23 pairs of chromosomes. The pair of chromosomes that determined his sex are named "XY." The sperm carries one chromosome from each of the male’s pairs (23 chromosomes). The sperm can carry either an "X" or a "Y" sex chromosome.

c. If the ovum is fertilized by a sperm carrying an "X" chromosome, the child is a girl.

d. If the ovum is fertilized by a sperm carrying a "Y" chromosome, the child is a boy.

e. The **sperm** of the **father** always **determines** the **child’s sex** (see figure 2-5).

![Figure 2-5. Genetic determination of sex.](image)
2-5. PLACENTAL DEVELOPMENT

The placenta is a fleshy disk like organ. The fully developed placenta (afterbirth) is reddish in color. It is formed from the outer layers of the blastocyst. It is completely formed by the third month of pregnancy. The umbilical cord (lifeline) connects the fetus to the placenta and is normally 20 inches in length and 3/4 inch in diameter. It contains one umbilical vein and two umbilical arteries.

2-6. FUNCTIONS OF THE PLACENTA

Being knowledgeable of the placenta functions gives insight into prenatal life and is helpful in providing nursing care to the unborn and the newborn. The placenta functions as a transport mechanism between the embryo and the mother (see figure 2-6). The placenta has many tasks: it transports oxygen, nutrients, and antibodies to the fetus by means of the umbilical vein; removes carbon dioxide and metabolic wastes from the fetus by the two umbilical arteries; serves as a protective barrier against harmful effects of certain drugs and microorganisms; acts as a partial barrier between the mother and fetus to prevent fetal and maternal blood from mixing; and produces hormones essential for maintaining the pregnancy. (The hormones are estrogen, progesterone, and human chorionic gonadotropin (HCG)).

Figure 2-6. The placental circulation.
2-7. FETAL MEMBRANES

Two closely applied but separate membranes line the uterine cavity and surround the developing embryo-fetus. Both membranes, the amnion (inner membrane) and the chorion (outer membrane), arise from the zygote. As the chorion develops, it blends with the fetal portion of the placenta; the amnion blends with the fetal umbilical cord. These deceptively strong, translucent membranes contain not only the fetus but also the amniotic fluid, and they are continuous with the margins of the placenta. See figure 2-7.

Figure 2-7. Fetal membranes.

a. Amnion. This is the smooth, slippery, glistening innermost membrane that lines the amniotic space. It is filled with fluid and is often called the "bag of water." The fetus floats and moves in the amniotic cavity. At full term, this cavity normally contains 500 cc to 1000 cc of fluid (water). This fluid provides many functions for the fetus. The amnion usually ruptures just before birth. The amnion functions to:

1. Protect the fetus from direct trauma by distributing and equalizing any impact the mother may receive.

2. Separate the fetus from the fetal membranes.

3. Allow freedom of fetal movement and permits musculoskeletal development.

4. Facilitate symmetric growth and development of the fetus.

5. Protect the fetus from the loss of heat and maintains a relative, constant fetal body temperature.
(6) Serve as a source of oral fluid for the fetus.

(7) Act as an excretion and collection system.

b. **Chorion.** This is the outer membrane. It forms a large portion of the connective tissue thickness of the placenta on its fetal side. It is the structure in and through which the major branching umbilical vessels travel on the surface of the placenta.

### 2-8. FETAL GROWTH AND DEVELOPMENT

Growth refers to an increase in size. Development is the continuous process by which an individual changes from one life phase to another. These phases includes the prenatal period and the postnatal period. Fetal maturation takes place in an orderly and predictable pattern. The physicians refer to the age of a pregnancy as lunar months. The lunar months corresponds to the usual length of the menstrual cycle, in this respect, it is easier to calculate. A lunar month is a period of four weeks (28 days) and a trimester is a time period of 3 months.

#### a. First Trimester.** During the first three months of pregnancy, the product of conception grows from the just-visible speck to the fertilized ovum to a lively embryo. At the end of the first trimester, the following changes have or are occurring:

1. All organs are formed.
2. The fetus becomes less vulnerable to the effects of most drugs, most infections, and radiation.
3. Facial features are forming and the fetus becomes human in appearance.
4. External sex organs are visible, but positive sex identification is difficult.
5. Well-defined neck, nail beds beginning, and tooth buds form.
6. Rudimentary kidneys excrete small amounts of urine into the amniotic sac.
7. There is movement but just not strong enough to be felt.
8. The fetus is about 2.9 inches long and weighs about 14 grams.

#### b. Second Trimester.** During these months (4th, 5th, and 6th) the fetus grows fast. At the end of the second trimester, the fetus:

1. Fetal heart tone (FHT) can be heard with a stethoscope.
(2) Skin is wrinkled, translucent, and appears pink.
(3) Sex is obvious.
(4) Looks like a miniature baby.
(5) Skeleton is calcified.
(6) Birth survival is possible, but the fetus is seriously at risk.

c. **Third Trimester.** At the end of the third trimester (7th, 8th, and 9th month), the fetus:

(1) Skin is whitish pink.
(2) Hair in single strands.
(3) Testes are in the scrotum, if a male child.
(4) Bones of the skull are firmer, comes closer at the suture lines.
(5) Lightening occurs.
(6) Fetus is about 20 inches long and weighs about 3300 grams.

**NOTE:** Lightening is defined as the sensation of decreased abdominal distention produced by the descent of the uterus into the pelvic cavity. This usually occurs two weeks before the onset of labor.

2-9. **DURATION OF PREGNANCY**

a. The length of pregnancy varies greatly. Nevertheless, the normal duration of pregnancy is about 9 1/2 to 10 months (lunar), 38 to 40 weeks.

b. It is usually not possible to determine the actual time of fertilization because reliable records concerning sexual activities are seldom available. However, the approximate time can be calculated.

c. The estimated date of confinement (EDC) is calculated as follows:

(1) The first day of last menstrual period.
(2) Count back 3 months.
(3) Add seven days.
(4) Add one year.
2-10. ASSESSING FETAL MATURITY AND WELL-BEING

Indications for assessing fetal maturity includes: determining the appropriate time for inducing labor, avoiding prematurity, and guarding the high-risk mother. Varieties of tests of the fetus status are of value in monitoring the well being of the fetus. Evaluation of fetal maturity and well-being is essential in the management of the high-risk pregnancy. The following test may be used:


(1) Definition. Amniocentesis is withdrawal of amniotic fluid by insertion of a needle through the abdominal and uterine walls (see figure 2-8).

![Figure 2-8. Amniocentesis.](image)

(2) When done. This procedure is possible after the 14th week of pregnancy when the uterus becomes an abdominal organ and when there is sufficient fluid for the procedure.

(3) Information obtained by amniocentesis.

(a) Color of fluid. The fluid is usually colorless. If it is meconium (stool) stained, it will be greenish brown and this indicates fetal hypoxia.

(b) Detects fetal chromosomal anomalies such as Down's Syndrome.

(c) Helps to evaluate the probability of sex-linked genetic disorders.

(d) Indicates fetal maturity, in-born errors, or metabolism, (indicates disorders like PKU).
(4) **Risks of the procedure.** Overall complications are less than 1 percent for the mother and the fetus. Possible risks are:

(a) **Maternal.**

1. Hemorrhage.
2. Infection.
3. Labor.
4. Inadvertent damage to the intestines or bladder.

(b) **Fetal.**

1. Death.
2. Hemorrhage.
3. Direct injury from the needle.
4. Abortion.
5. Premature labor.

b. **Non-Stress Test.** It evaluates the ability of the placenta to supply fetal needs in a normal (or unstressed) daily uterine environment.

(1) The non-stress test (NST) involves application of the fetal monitor to record the fetal heart rate. The mother is instructed to push a marker button when she feels the fetus move. The marker button indicates movement as it occurred in relationship to the fetal heart rate. With sufficient placental functioning, the fetus should demonstrate an acceleration in heart rate with movement, in the same way that the adult experiences increased heart rate with exercises. A lack of fetal heart rate acceleration indicates the need for further testing.

(2) Non-stress test is used to screen the high-risk pregnancy where the placental compromise is anticipated to include post-term pregnancy, pregnancy induced hypertension, gestational diabetes, intrauterine growth retardation, and maternal complaints of decreased fetal movement.

(3) Patients identified as NST candidates will generally be required to complete an NST on a regular basis (that is, weekly, bi-weekly).
c. Methods of Contraction Production.

(1) Oxytocin challenge test (OCT). A dilute of I.V. solution of oxytocin is administered to the mother until a contraction pattern is developed. When sufficient information is obtained to evaluate the test, the medication is turned off.

(a) The Oxytocin challenge test evaluates the ability of the placenta to supply fetal needs in a stressed environment. Contractions, such as those of labor, are a stress on the pregnancy. During a contraction, the flow of oxygen from the uterus to the placenta is diminished. The healthy placenta stores an oxygen reserve so that the fetus does not suffer a diminished supply of oxygen during the contraction.

(b) The OCT involves application of the fetal monitor to record fetal heart rate and contraction activity. Acceptable results include acceleration of fetal heart rate or no change in fetal heart rate baseline during a contraction. Unacceptable results include deceleration of fetal heart rate during a contraction.

(c) The OCT is used to evaluate the high-risk pregnancy where the placental compromise is suspected. It is often applied to the same high-risk patients listed under NST. In addition, it is used to evaluate the patient when a suspicious result is obtained on an NST. The OCT is more invasive than the NST; it provides more conclusive results than the NST.

(2) Breast stimulation test (BST). This test involves stimulation of the nipples (by rubbing), which causes the posterior pituitary to release the hormone oxytocin, which in turn, causes contractions.

(3) Contraction stress test (CST). Evaluation is done in the presence of naturally occurring contractions. It is a means of evaluating the respiratory function (oxygen and carbon dioxide exchange) in the placenta.

2-11. COMPONENTS OF FETAL CIRCULATION

As the placenta acts as the intermediary organ of transfer between the mother and fetus, fetal circulation differs from that required for extrauterine existence. The fetus receives oxygen through the placenta because the lungs do not function as organs of respiration in the uterus. To meet this situation, the fetal circulation contains certain special vessels that shunt the blood around the lungs, with only a small amount circulating through them for nutrition. See figure 2-9. The following functions occurs:
Figure 2-9. Fetal circulation before birth.

a. The umbilical vein transports blood rich in oxygen and nutrients from the placenta to the fetal body. This vein travels along the anterior abdominal wall of the fetus to the liver, and at the porta hepatis, the umbilical vein divides into two branches.

b. About 1/2 of the blood passes into the liver and the rest enters a shunting vessel called the ductus venosus that bypasses the liver. The ductus venosus travels a short distance and joins the inferior vena cava.

c. There, the oxygenated blood from the placenta is mixed with deoxygenated blood from the lower parts of the fetal body. This blood continues through the vena cava to the right atrium.

d. As the blood relatively high in oxygen enters the right atrium of the fetal heart, a large proportion of it is shunted directly into the left atrium through an opening in the atrial septum called the foramen ovale.

e. The more highly oxygenated blood that enters the left atrium through the foramen ovale is mixed with a small amount of deoxygenated blood returning from the pulmonary veins. This mixture moves into the left ventricle and is pumped into the aorta.
f. Some of this blood reaches the myocardium by means of the coronary arteries and some reaches the tissues of the brain through the carotid arteries.

g. The rest of the blood entering the right atrium, as well as the large proportion of the deoxygenated blood entering from the superior vena cava, passes into the right ventricle and out through the pulmonary artery.

h. Enough blood reaches the lung tissues to sustain them.

i. Most of the blood in the pulmonary artery bypasses the lungs by entering the ductus arteriosus, which connects the pulmonary artery to the descending portion of the aortic arch.

j. Some of the blood carried by the descending aorta leads to the various parts in the lower regions of the body.

k. The rest of the blood passes into the umbilical arteries which branch from the internal iliac arteries and lead to the placenta.

2-12. CHANGES CONTINUE IN CIRCULATION AFTER BIRTH

See figure 2-10.

Figure 2-10. Fetal circulation after birth.
a. The **umbilical vein** is obliterated and becomes the round ligament of the liver.

b. The **umbilical arteries** are obliterated and ultimately become ligaments.

c. The **ductus venosus** is obliterated and becomes a ligament. Anatomic closure is completed at the end of 2 months. The ductus venosus is superficially embedded in the wall of the liver.

d. The **ductus arteriosus** is obliterated and becomes a ligament. Functional closure takes 3-4 days; anatomic closure is completed by 3 weeks. The constriction seems to be stimulated by a substance called Bradykinin, which is released from the lungs during their initial expansions.

e. The **foramen ovale** closes after the umbilical cord is tied and cut. A large amount of blood is returned to the heart and the lungs. With the lungs now functioning, there is equal pressure on both atria as the vessels constrict. Failure of the foramen ovale to close spontaneously results in an atrial septal defect, which may or may not require surgery later.

**2-13. PRINCIPLES OF FETAL IMMUNOLOGY**

a. During the third trimester, passive immunity to some diseases is provided by the mother.

b. Diseases that the fetus receives temporary protection from include:

   (1) Rubella.

   (2) Diphtheria.

   (3) Measles.

   (4) Poliomyelitis.

   (5) Tetanus.

   (6) Mumps.

c. Passive immunity is short term and infants must begin immunization against the above diseases by the age of 2 months.

**2-14. MULTI-FETAL PREGNANCIES**

a. Multi-fetal pregnancy is a pregnancy involving two or more fetuses.

b. Twin fetuses may originate several ways (see figure 2-11).
(1) Identical twins (monozygotic) originate from the same ovum and are always of the same sex. They share a single placenta.

(2) Fraternal twins (dizygotic) originates from two separate ova and sperm and may be of different sexes. They each have their own placenta.

c. Pregnancies involving more than two fetuses (that is, triplets, quadruplets) may occur by either situation.

(1) Monozygotic--all will be identical.

(2) Multi-zygotic--often associated with fertility drugs in which the ovary matured and released many eggs in the same cycle.
2-15. CLOSING

In closing, a working knowledge of the development of the human baby from conception to birth is essential for you to function effectively as a practical nurse. The information covered in this lesson, along with Lesson 1, will help you in carrying out the nursing process in labor and delivery, and caring for the newborn infant.

*Continue with Exercises*

*Return to Table of Contents*
EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space(s) provided.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Of the two fetal membranes, which one is the smooth, slippery, glistening innermost membrane that lines the amniotic space?

2. How long (number of months) is a trimester?

3. Lightening occurs during the trimester.

4. What is the normal duration of pregnancy?

5. What tests are used to assess fetal maturity and well-being?

6. Possible maternal risk of the amniocentesis includes:

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For exercises 7 through 16. Use the following terms to complete the sentences or statements.

fertilization  pregnancy
zygote  multizygotic
placenta  chorion
lunar month  fraternal twins
identical twins  growth
monozygotic

7. _______________________ originate from the same ovum and are always of the same sex.

8. An increase in size is known as _______________________.

9. The ___________________ is the outer membrane of the two fetal membranes.

10. The _______________________ is a fleshy disklike organ.

11. The combined ovum and sperm. _______________________.

12. A sequence of events that normally includes fertilization, implantation, embryonic growth, and fetal growth that terminates in birth. _______________________.

13. The joining together of the ovum and sperm cells is referred to as ____________.

14. A period of four weeks (28 days). _________________________

15. The result of pregnancies involving two or more fetuses is known as ________________________ and ________________________.

16. Twins from two separate ova and sperm and may be of different sexes. _________________________
17. During the third trimester, passive immunity to some diseases is provided by the mother. The fetus receives temporary protection from the following diseases:

_______________________
_______________________
_______________________
_______________________
_______________________
_______________________

18. What changes occur in circulation after birth to the following parts?

Umbilical vein - _______________________
Ductus venosus - _______________________
Umbilical arteries - _______________________
Foramen ovale - _______________________
Ductus arteriosus -

19. The ______________________ acts as the intermediary organ of transfer between the mother and the fetus.

20. How does the fetus receive oxygen? _______________________

Check Your Answers on Next Page
SOLUTIONS TO EXERCISES, LESSON 2

1. amnion (para 2-7a).
2. 3 months (para 2-8).
3. 3rd (para 2-8c(5)).
4. 9 1/2 to 10 months (para 2-9a).
5. Amniocentesis.
   Non-stress test.
   Oxytocin challenge test.
   Breast stimulation test.
   Contraction stress test (paras 2-10a, b, and c).
6. hemorrhage.
   Infection.
   Labor.
   inadvertent damage to the intestines or bladder (para 2-10a(4)(a)).
7. identical twins (para 2-14b(1)).
8. growth (para 2-8).
9. chorion (para 2-7b).
10. placenta (para 2-5).
11. zygote (para 2-2c).
12. pregnancy (para 2-1).
13. fertilization (para 2-2a).
14. lunar month (para 2-8).
15. monozygotic
    multi-zygotic (para 2-14c).
16. fraternal twins (para 2-14b(2)).
17. rubella.
   Diphtheria.
   Measles.
   Poliomyelitis.
   Tetanus.
   mumps (para 2-13b).

18. Umbilical vein--is obliterated and becomes the round ligament of the liver.
   Ductus venosus--is obliterated and becomes a ligament.
   Umbilical arteries--are obliterated and ultimately becomes ligaments.
   Foramen ovale--closes after birth, after the umbilical cord is tied and cut.
   Ductus arteriosus--is obliterated and becomes a ligament. (para 2-12).

19. placenta (para 2-11).

20. through the placenta (para 2-11).

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