

HEREDITY AND PRENATAL DEVELOPMENT

Chapter 2

CHAPTER OVERVIEW

This chapter provides an overview of the biological processes of heredity and conception, including all of the basic structures (chromosomes, genes, DNA) and processes (mitosis, meiosis, fertilization, implantation) involved in the formation of a new human being. Students will learn the different causes and types of chromosomal and genetic abnormalities. The relationship between genotype and phenotype in developmental outcome is described, and the potential disorders resulting from various chromosomal and genetic abnormalities are discussed. Research strategies for examining the contribution of genes and environment to development are introduced. The chapter includes a discussion of infertility and genetic counseling, alternative pregnancy methods, and parental attempts to select the gender of their child. A brief discussion of the benefits of adopting children is presented. The chapter describes the preimplantation genetic diagnosis process. Students will be able to compare and contrast the different stages of prenatal development (germinal, embryonic, and fetal). Sexual differentiation is explained in detail. The role the amniotic sac, amniotic fluid, and placenta play in the development and delivery process is presented. The changes in the fetus throughout the pregnancy cycle are explained. Students will be able to identify the different types of teratogens that can affect the health of the developing fetus as well as the stage of development where harm can occur. This chapter describes the impact of drugs that are most likely to affect the healthy development of a fetus (aspirin, thalidomide, hormones, vitamins, heroin, methadone, marijuana, alcohol, cocaine, caffeine, and cigarettes). The chapter concludes with a discussion of the environmental effects on the development of the fetus such as prenatal exposure to lead and the age of the parents at conception.

CHAPTER LEARNING OBJECTIVES

Having read the chapter, students should be able to:

- Explain the difference between a gene and a chromosome, and explain how a baby's sex is determined
- Describe the processes of mitosis and meiosis
- Identify the difference between monozygotic and dizygotic twins and describe how they are developed

- Describe the process of genetic transmission, or how traits are passed from parents to children
- Discuss the causes and characteristics associated with chromosomal and genetic abnormalities
- Explain how Down's syndrome occurs as well as its physical markers
- Describe how sex-linked chromosomal abnormalities occur
- Identify, compare, and contrast the different sex-linked chromosomal disorders (Klinefelter syndrome, Turner syndrome)
- Identify, compare, and contrast disorders that have been contributed to genes (PKU, Huntington's disease, Sickle-Cell Anemia, Tay-Sachs disease, and Cystic Fibrosis)
- Identify, compare, and contrast sex-linked genetic abnormalities (Hemophilia, Duchenne Muscular Dystrophy)
- Identify and explain different prenatal testing techniques used for various genetic disorders
- Describe how studies of kinship, adopted children, and identical (monozygotic) versus fraternal (dizygotic) twins are used to explore the relative influences of nature (heredity) versus nurture (environment)
- Explain the formation of egg and sperm and where conception takes place
- Define the following terms: ova, endometrium, sperm cells, and spontaneous abortion
- Discuss causes of infertility and methods couples can use to conceive
- Discuss the benefits of adopting children
- Describe the preimplantation genetic diagnosis process
- Define, compare, and contrast the different stages of prenatal development (germinal, embryonic, and fetal)
- Explain how sexual differentiation occurs
- Describe the role the amniotic sac, amniotic fluid, and placenta play in the development and delivery process
- Describe changes in the fetus throughout the pregnancy cycle

- Identify the different types of teratogens that can affect the developing fetus' health as well as the developmental stage where harm can occur
- Describe the impact of drugs that are most likely to affect the healthy development of a fetus (aspirin, thalidomide, hormones, vitamins, heroin, methadone, marijuana, alcohol, cocaine, caffeine, and cigarettes)
- Describe environmental effects on the fetus' development such as prenatal exposure to lead and/or the parents' age at conception

CHAPTER OUTLINE

1. The Influence of Heredity on Development
 - a. Genetic influences on development
 - i. Fundamental in the transmission of physical traits
 - ii. Plays a role in psychological traits
 - iii. Involved in psychological disorders
2. Chromosomes and Genes
 - a. Definitions of chromosomes, genes, polygenic, and DNA
 - b. Explanation of mitosis, meiosis, and mutations
 - c. Discussion of autosomes and sex chromosomes
 - d. Development of monozygotic (MZ) and dizygotic (DZ) twins
 - e. How traits are determined
 - f. Definitions of alleles, homozygous, heterozygous, dominant trait, recessive trait, carriers, and multifactorial problems
3. Chromosomal Abnormalities
 - a. Down's syndrome
 - b. Discussion of sex-linked chromosomal abnormalities (Klinefelter syndrome, Turner syndrome, and Triple X syndrome)
4. Genetic Abnormalities
 - a. Transmission of phenylketonuria (PKU)
 - b. Huntington's disease (HD)
 - c. Sickle-cell anemia and disease statistics
 - d. Tay-Sachs disease
 - e. Cystic fibrosis
 - f. Sex-linked genetic abnormalities
 - i. Hemophilia and Duchenne Muscular Dystrophy
5. Genetic Counseling and Prenatal Testing
 - a. Prenatal testing
 - b. Amniocentesis: purpose and process
 - i. Risks
 - c. Chorionic villus sampling (CVS): Purpose and process
 - i. Risks
 - d. Ultrasound and sonogram: Purpose and process

- e. Alpha-fetoprotein (AFP) assay: Purpose and process
- 6. Heredity and the Environment
 - a. Genotypes
 - b. Phenotypes
- 7. Kinship Studies
 - a. Kinship studies: Purpose
- 8. Twin Studies: Looking in the Genetic Mirror
 - a. Why MZ and DZ twin studies occur
 - i. Minnesota Study of Twins Reared Apart
 - ii. Contribution of MZ and DZ twin studies
- 9. Adoption Studies
 - a. Contribution of adoption studies
- 10. Conception: Against all Odds
 - a. Conception
 - b. The role of ova and hormones in fertilization
 - i. Endometrium
 - c. Sperm cell development stages
 - d. Problems affecting male fetus development
 - i. Conception, birth rate and infant mortality
- 11. Infertility and Alternative Ways of Becoming Parents
 - a. Causes of infertility
 - i. Males – motility
 - ii. Females – ovulation, pelvis inflammatory disease (PID), and endometriosis
 - b. Artificial insemination procedure
 - c. In Vitro Fertilization (IVF)
 - i. IVF and Donor IVF
 - d. Surrogate mothers
 - e. Adoption
 - f. Selecting the Sex of Your Child
 - g. Preimplantation Genetic Diagnosis (PGD) process
- 12. Prenatal Development
 - a. The Germinal stage: Wanderings
 - i. Blastocyst
 - 1. Embryonic disk
 - 2. Trophoblast
 - ii. Umbilical order and placenta
 - iii. Amniotic sac
 - iv. Chorion
 - b. The Embryonic stage
 - i. Development follows cephalocaudal (“head to tail”) and proximodistal (“near to far”)
 - ii. Ectoderm (outer layer of cells of the embryonic disk) and neural tube develop
 - iii. Endoderm (inner layer) develop
 - iv. Mesoderm develop

- v. How sexual differentiation occurs
 - vi. Role of the amniotic sac and amniotic fluid
 - vii. Role of the placenta: A filtration system
- c. The Fetal stage
 - i. First trimester
 - ii. Second trimester
 - iii. Third trimester
 - iv. Changes in fetal development
 - 1. Fetal perception
 - 2. Fetal movements
- 13. Environmental Influences on Prenatal Development
 - a. Role of nutrition
 - b. Contributing factors to stillbirth
- 14. Teratogens and Health Problems of the Mother
 - a. Exposure to teratogens during critical periods
 - b. Critical Periods of Vulnerability
 - c. Sexually transmitted infections
 - i. Syphilis
 - ii. HIV/AIDS
 - d. Rubella
 - e. Preeclampsia/Toxemia
 - f. Rh incompatibility
- 15. Drugs Taken by the Parents
 - a. Thalidomide birth defects
 - b. Hormones
 - i. DES
 - c. High doses of vitamins A and D
 - d. Heroin and methadone; effects on newborns
 - e. Marijuana (Cannabis); risks to fetus
 - f. Cocaine Abuse
 - i. Risk of stillbirth, low birth weight (LBW), and birth defects
 - g. Alcohol
 - i. Risk for embryo and fetus
 - ii. Fetal alcohol syndrome
 - h. Caffeine Studies
 - i. Conflicting results
 - i. Cigarettes
 - i. Risks to fetal development
- 16. Environmental Hazards
 - a. Risks of lead, mercury, zinc, polychlorinated biphenyls, and radiation on development
- 17. Parents' Age
 - a. Older fathers
 - i. Sperm abnormalities
 - b. Mother's age
 - i. Child developmental issues

DISCUSSION TOPICS

Say “Cheese”: Prenatal Pictures

Although ultrasounds were developed for medical purposes, many companies now offer pregnant women 3-D and 4-D ultrasounds in order to see their babies before they are born. 3-D ultrasounds almost look like photographs (there are several examples on the web). 4-D (four dimensional) ultrasounds add the element of time to three-dimensional ultrasound images, so that women can purchase a video of their unborn child moving around. These ultrasounds do not provide any medical information about the health or gestational age of the baby.

Alcohol and Culture

Many doctors in the U.S., along with the Centers for Disease Control and the U.S. Surgeon General, state that no amount of alcohol is safe for developing fetuses and recommend complete abstinence from drinking during pregnancy. Several countries agree with this policy recommending abstinence alone. In contrast, other countries have policies that recommend abstinence as the safest choice but also indicate that small amounts of alcohol are unlikely to cause harm. Still others recommend that a low alcohol intake poses a low risk to the fetus. This variation in policies stems from the lack of clarity in the research literature about the relationship between low levels of alcohol consumption and fetal effects. (It is clear that high levels cause fetal alcohol syndrome!) Australia reviewed their policies in 2007, but as of 2001 the National Health and Medical Research Council advised, “Abstinence may be considered and that, if a woman does drink during pregnancy, she should consume no more than seven standard drinks a week and, on any one day, no more than two standard drinks, spread over at least 2 hours.” They also advise that under no circumstances should a pregnant woman become intoxicated (O’Leary, Heuzenroeder, Elliott, & Bower, 2006, p.466). It is interesting to consider the interpretation of scientific research in the context of different cultures. This can lead to a class debate on alcohol policy in the United States.

O’Leary, C. M., Heuzenroeder, L., Elliott, E. J., & Bower, C. (2006). A review of policies on alcohol use during pregnancy in Australia and other English-speaking countries, 2006. *The Medical Journal of Australia*, 186(9), 466-471.

Genotype-Environment Effects

The textbook briefly points out that expressed traits represent an interaction of heredity and environment. Discuss with your students the bidirectional effects of biology and environment. Explain to them each of the influences on development. For example, in the passive genotype-environment effect, biological parents provide both their child’s DNA and their environment. Parents who are talented musicians may pass down genes that allow a child to develop perfect pitch in an environment with high levels of exposure to music. Thus, the child may express musical talent. This influence is greatest during early development when a child’s environment is most influenced by his or her parents.

Discuss the second influence (evocative genotype-environment interaction). In this case, a child's genotype will evoke certain responses from those around them and influence his or her development. For instance, a child's genotype may cause her to grow especially tall. This may evoke those around the child to encourage her to play basketball. Classmates may pick that child for teams first during gym class. This could influence the child to become quite athletic. Evocative genotype-environment effects operate throughout the lifespan.

Finally, describe the active genotype-environment effect as a type of niche picking. People will seek out environments they are comfortable in and that are consistent with their traits. Consider the example above of the tall child. This child may choose to try out for the school basketball team and actively seek out opportunities to practice this sport. This influence becomes more prominent as a child matures and is able to make his or her own choices in life.

Microsort®: Sex-Selection by Sperm Sorting

One new technology that can be used as part of the lecture on sex-selection not discussed in the text is Microsort® (Genetics & IVF Institute, 2007). This method, currently used in clinical trials, sorts sperm before conception to increase the proportion of either sperm containing either an X or Y chromosome, depending on the desired sex. The sperm is then used via intrauterine insemination or in vitro fertilization. Thus, the chances of having a girl or boy are also increased. The sorting is based on differences in the amount of DNA: sperm cells with an X chromosome contain approximately 2.8 percent more total DNA than sperm cells having a Y chromosome. This DNA difference can be measured and the X- and Y-bearing sperm cells individually separated using a modified flow cytometer instrument. However, this technology does not result in the complete exclusion of either X- or Y-bearing sperm from the final sperm preparation, meaning that this method is not 100 percent accurate like Preimplantation Genetic Diagnosis (PGD). In fact, Microsort® results in an average increase of X-bearing sperm to 88 percent and as of January 2007, 92 percent of the babies born via this method have been female. The accuracy rate is lower for males: sperm samples were on average 73 percent Y-bearing (male) and 81 percent of the babies have been male. Currently, to use this technology, couples must be married and seeking to avoid transmitting a sex-linked genetic disorder or seeking gender balance in their family. Furthermore, using this technology is quite expensive. This technology is the center of an ethical debate that you can discuss with your students. Some of the moral and ethical issues surrounding this technology have been articulated in the January 26, 2004 issue of Newsweek magazine.

Genetics & IVF Institute. (August, 2007). Microsort®. Retrieved August 16, 2007 from <http://www.microsort.net/index.php>

Intersex Infants

This chapter touches on the complexities of genetics and prenatal hormone exposure in determining whether a child develops as a male or a female. However, there are many conditions that may result in the birth of baby having external genitalia that is neither clearly male nor clearly female. Many have referred to these children as intersex babies, but recently some have suggested referring to these infants as having a DSD (disorder of sex development) (Lee et al., 2006). Two common conditions resulting in the birth of intersex individuals are congenital adrenal hyperplasia (CAH) and androgen insensitivity syndrome (AIS). In CAH, XX children may be born with masculinized genitalia due to a malfunction in an enzyme involved in making steroid hormones. In AIS, XY children may be born with highly feminized genitalia since the body did not respond to androgens in utero. Estimates of the frequency of intersex births hover around 1.7 percent of all births (Fausto-Sterling, 2000). The birth of an intersex child can be unsettling and stressful for parents who are expecting to hear “It’s a Boy!” or “It’s a Girl!” In the past, many doctors rushed to assign a gender and do surgery on infants to make their external genitalia conform to this assignment. Today, improved understanding of the many genetic, hormonal, and psychosocial influences on gender, as well as the advocacy of adult intersex individuals has slowed this practice. In 2006, a large group of pediatricians recommended the following standards of care for intersex individuals: “(1) gender assignment must be avoided before expert evaluation in newborns; (2) evaluation and long-term management must be performed at a center with an experienced multidisciplinary team; (3) all individuals should receive a gender assignment; (4) open communication with patients and families is essential, and participation in decision-making is encouraged; and (5) patient and family concerns should be respected and addressed in strict confidence” (Lee et al., 2006, p.490). The advocacy of groups such as the Intersex Society of North America has led to many of these policy changes. Cheryl Chase, who founded this society objected to genital surgery for infants on the grounds that surgery implies their condition is socially unacceptable, it may damage sexual sensitivity, and the surgery may produce a physical appearance that is discordant with the mental state of the individual (i.e., make them the “wrong” sex) (Chase, 2001). A discussion of intersex individuals is often fascinating to students. Have them consider the physical causes of the conditions, the perspectives of parents and children, the social stigma, and the legal ramifications (i.e., some states will not allow the sex on a birth certificate to be changed and will not allow same-sex marriage).

Chase, C. (2003). What is the agenda of the intersex patient advocacy movement? *Endocrinologist*, 13(3), 240-242.

Fausto-Sterling, A. (2000). *Sexing the Body*. New York, NY: Basic Books.

Lee, P.A., Houk, C. P., Ahmen, S. F., Hughes, I. A., & International Consensus Conference on Intersex organized by the Lawson Wilkins Pediatric Endocrine Society and the European Society for Pediatric Endocrinology (2006). Consensus statement on management of intersex disorders. *Pediatrics*, 118(2), e488-500.

CLASS ACTIVITIES AND PROJECTS

Case Study

Divide the class into small groups (no more than five per group). Present the class with the following case study: Eleanor began taking prenatal vitamins three months prior to conception, and she stopped consuming alcohol in the month prior to conception. Ask the groups to identify what problems her careful, planned approach may likely rule out. Answers should include some of the following: fetal alcohol syndrome, spina bifida (folic acid). Next, ask the students to identify other behaviors that may affect the health of a child prior to, or very early in, pregnancy. Group answers should include some of the following: exercise, diet, drug use, and smoking.

Folk Wisdom

Perhaps no other period of life generates as much fascination and misinformation as the gestation and delivery of a new baby. Folk wisdom, or old wives' tales, concerning pregnancy and birth are still passed on today. Some are based on fact and observation; others are derived from fears or a cultural belief. Ask students to gather some folk wisdom about determining the sex of the fetus. While relatives are a good source, you can also make this a cross-cultural study and suggest that students do some research into the folk wisdom of specific cultures in relationship to determining the fetus' sex. Have students complete this project in advance, so their findings can be presented and discussed during class along with the chapter information.

Nature vs. Nurture: How do these ideas influence real life?

This activity can be structured as a whole-class discussion, a small-group discussion, or for individual discussion papers. If you place students into small groups, keep the number of members under five. Ask students to address the following question: "Why is it important to try and determine the relative contribution of heredity and environment in development?" Students should be encouraged to think about the implications that arise from a conclusion that a given trait is mostly genetically influenced or mostly environmentally influenced. Students should discuss: What are the implications for promoting development? What are the implications for remediating deficits? What are the implications for the conclusion that the trait develops from both genetic and environmental effects? Have students generate specific examples (e.g., intelligence, shyness) upon which to build their discussion. You may also want to have advanced students explore how these ideas may have contributed to genocide campaigns and "ethnic cleansing."

Illustrating a Reaction Range

Gottman's conceptualization of heredity-environment interactions is called range of reaction. It is the notion that genetics set upper and lower limits on environmental influences (e.g., nutrition, learning, accidents, illness, environmental toxins, schooling, and social class). One way to help your students grasp this concept is to have them generate examples of how multiple phenotypes are possible from one genotype in the areas of physical, cognitive, and social development. First, have them propose traits they think are very heavily influenced by heredity and traits and ones they think have

very little genetic influence. Next, have students think about what genetics might direct in the phenotype (e.g., two tall parents pass on genes for tall height to their children). Finally, have students place that genotype in a variety of environments (e.g., poor nutrition, adequate nutrition, excellent nutrition) and describe the multiple outcomes. You might have students generate graphs of their examples as a way to highlight the way heredity and environment interact in this model.

The Cost of Infertility

Have students research health insurance policies (their own, their parent's policy, or a policy they would be eligible to purchase from a local provider). Have them create a report showing the financial coverage that their health insurance provides for infertility treatments and/or adoption costs. Many policies will not pay for any of these treatments. Next, have students investigate the cost of these infertility treatments and the fees associated with private adoptions. Finally, have students discuss these findings in terms of social policy on health care. Do these costs make treatments unattainable for lower-income families? Explain.

Before You Get Pregnant

Although many of the recommendations made in this chapter involve things to do once you are pregnant, many women in today's world plan on becoming pregnant. Have students make a list of things they should do *before* becoming pregnant (make sure the woman's rubella vaccine is up-to-date; stop taking certain medications, etc.).

Everyday Exposure to Teratogens

This chapter lists many possible teratogens. Have students list all of the teratogens listed in the chapter they have been in contact with in the last week (cigarette smoke, alcohol, mercury from certain fish, radiation from dental X-rays, etc.).

Illegal Drug Use during Pregnancy

Recent cases have discussed mothers who were held in custody to prevent them from using illegal drugs or drinking during pregnancy. This was done on the grounds that courts have some responsibility to protect the unborn infant. Have students search the web to find more information about these cases and, after learning about some of the case specifics, have them write a paragraph about whether or not they think this is a useful strategy. Also have them consider the question about whether or not drug use during pregnancy should be considered child abuse and therefore be punishable under the law. If so, what kind of punishment would be appropriate? Should individuals who sell or serve alcohol to a pregnant woman be held accountable?

Pregnant and Poor

This chapter discusses the importance of good prenatal care for maintenance of good health and adequate nutrition for the mother. Have students search the Internet for sources of prenatal care and access to medical care and food for mothers who live in poverty.

Genes and Environment: Article Review

A fascinating and easy-to-read article recently published in *Psychology Today* may help students understand how genes and environmental influences affect complex personality traits. Have your students read this article, which can be found in a library or online: Sinha, G. (March/April 2004). The identity dance. *Psychology Today*, pp. 52, 57-58, 60-61, 63, 95. Students should then answer the following questions in a short discussion paper:

1. Describe what is meant by “Susceptibility is not inevitability.”
2. How were ideas from behavioral genetics used to explain the failure of welfare programs? In light of the above statement (“Susceptibility is not inevitability”), how should these ideas be modified? What does this mean for welfare programs?
3. Although the monkeys Jim and George had the same transporter gene, they behaved quite differently. Why did researchers think these monkeys acted so differently? What could have been done to prevent George’s alcoholism?
4. According to a study by Moffit and Caspi, what made people carrying the short-versions of the transporter gene more likely to become depressed? If you knew you had this version of the gene, would you behave differently?

Pregnancy Advice to a Friend

After learning about the three stages of prenatal development, have students write out a list of 10 pieces of advice about pregnancy to a friend who has just learned they are pregnant. These can include information about what to expect during the pregnancy, what might enhance or detract from prenatal development, and what questions to make sure to ask the obstetrician.

BEYOND THE BOOK

Prenatal Assessment Risks

Using your textbook and Internet: Ask students to identify the risks associated with the following various prenatal assessment measures:

1. Maternal blood analysis, AFP screening (high risk of false positive result)
2. Amniocentesis (risk of losing the pregnancy to miscarriage)
3. Chorionic villus sampling (some concern about fetal limb abnormalities, increased risk of miscarriage)

Ask your students to find information on the Internet identifying how decisions are made regarding which measures to use. The following issues should be a part of their answer: Maternal age, stage of pregnancy, abnormal ultrasound findings, previous child with a genetic or other disorder, family history of genetic or other disorder, ethnic origin, and

multiple miscarriages. Ask your students to look up and identify ethical considerations stated on different websites in the use of prenatal monitoring procedures. Their answers should include the following: selective abortion controversies (i.e., sex), disability status, false negative/positive results and decision making, risk of miscarriage and infection. Make sure students cite the website address.

Birth Defects

Pair up students and ask them to use the textbook as well as the Internet to answer the following questions. Ask students to provide the website address. The questions are:

1. How prevalent are birth defects resulting from genetic factors?
2. How can the family histories of prospective parents be used to determine the likelihood of a baby with a genetic disorder?
3. What are some other, non-genetic factors that can affect prenatal development?
4. What are some critical time periods in pregnancy when the developing baby is more vulnerable than others? Describe these fetal changes in detail.

A Baby at Any Cost?

Have students pretend they are part of a couple who is beginning to fear they may have fertility problems. Have the students search the Internet for websites advertising fertility clinics. Ask students to answer the following questions based on the information provided by the websites: What kind of initial information do these sites provide with regard to chances of success? Are specific costs mentioned? What kind of variability is there in the types of services clinics provide? After examining some of these sites, have students reflect on how much they think they might be willing to spend on fertility treatments? How much would they be willing to borrow from relatives? Would they give up a chunk of their retirement fund? Would they be willing to forego the purchase of house? Would they be willing to forego vacations?

You Be the Infertility Counselor

In conjunction with their hour-long video Test Tube Babies, PBS offers a fun interactive web activity called "You Be the Counselor." This activity presents the case files of several couples trying to conceive and asks students what sort of fertility treatment they would recommend. Feedback is given on selection choice. This activity can be done as a class, in small groups, or with individual students. You can access this activity at <http://www.pbs.org/wgbh/amex/babies/sfeature/clinic.html>.

ANSWER KEY: TRUTH OR FICTION?

1. Your father determined whether you are female or male.

TRUE. If we receive another X sex chromosome from our fathers, we develop into females. If we receive a Y sex chromosome (named after its Y shape) from our fathers, we develop into males (Page 25).

2. Approximately 120 to 150 boys are conceived for every 100 girls.

TRUE. Sperm with Y sex chromosomes appear to swim faster than sperm with X sex chromosomes. This is one of the reasons why between 120 and 150 boys are conceived for every 100 girls (Page 33).

3. Sperm travels about at random inside the woman's reproductive tract, so reaching the ovum is a matter of luck.

FALSE. Although the journey of sperm is literally blind, it is not random. Sperm cells are apparently attracted by the odor of a chemical secreted by ova (Page 34).

4. "Test-tube" babies are grown in a laboratory dish throughout their nine-month gestation period.

FALSE. "Test-tube" babies are conceived in a laboratory dish or vessel and then injected into the uterus, where they must become implanted to develop successfully (Page 35).

5. Newly fertilized egg cells survive without any nourishment from the mother for more than a week.

TRUE. They are nourished by the yolk of the ovum until they implant in the wall of the uterus (Page 36).

6. Fetuses suck their thumbs, sometimes for hours on end.

TRUE. Just ask a weary pregnant woman! By the end of the second trimester, the fetus sucks its thumb and there are sharp spasms of the diaphragm, or fetal hiccups, which may last for hours (Page 39).

7. A father's age at the time of conception can influence the development of the fetus.

TRUE. Older fathers are more likely to produce abnormal sperm, leading to fertility problems. In addition, the older the father, the lower a child's score may be on tests of reading skills, reasoning, memory, and concentration (Page 45).

ADDITIONAL READING MATERIAL

Scarr, S. & McCartney, K. (1983). How people make their own environments: a theory of genotype greater than environment effects. *Child Development*, 54(2), 424-435.

VIDEO SUGGESTIONS

Cracking the Code of Life (2001, NOVA, 120 minutes). This video may also be viewed online through the interactive companion website:
<http://www.pbs.org/wgbh/nova/genome/>

All in the Genes (1998, Filmmakers Library, 52 minutes). Overview of cloning the new science of genetics, with a discussion of the implications for children with genetic disorders.

Genetic Translation (1996, Films for the Humanities and Social Sciences, 15 minutes). Covers the translation of genetic material into a living organism. Also includes a discussion of genetic testing and amniocentesis.

After Darwin: Genetics, Eugenics, and Human Genome (1999, Films for the Humanities and Social Sciences, 2 parts, 49 and 46 minutes).

Prenatal Testing: A Mixed Blessing (1995, Films for the Humanities and Social Sciences, 51 minutes). Follows four couples through prenatal testing and counseling, including a discussion of Down syndrome.

Gene Research: Promises and Dilemmas (Films for the Humanities and Social Sciences, 33 minutes). Covers difficulty of advising families about results of prenatal testing for diseases for which there is no cure.

Nature and Nurture Interwoven (1992, Insight Media, 30 minutes). Overview of controversy, including discussion of behavior genetics, heritability, twin studies, and cross cultural research.

Biological Growth: Nature's Child (1991, Insight Media, 60 minutes). Examines influence of heredity on intelligence, temperament, personality, sex differences, and mental illness.

The Mystery of Twins (2000, Insight Media, 52 minutes). Looks at how research on twins informs the nature-nurture question.

Supertwins: Triplets, Quads, and More (1998, Films for the Humanities and the Social Sciences, 1 hour, 44 minutes).

Making Babies (1999, PBS, 60 minutes). This video has an interactive companion website, <http://www.pbs.org/wgbh/pages/frontline/shows/fertility>, and includes online videos on high tech procedures, information on human cloning, and a short quiz.

18 Ways to Make a Baby (2001, NOVA, 60 minutes). An interactive website provides tutorials and other activities: <http://www.pbs.org/wgbh/nova/baby/>.

Reproduction: Designer Babies (1995, Films for the Humanities and Social Sciences, 20 minutes). Introduction to the structure and function of DNA, prenatal testing, genetic abnormalities, alternative pregnancy technology, and ethical issues.

Baby Making: The New Art of Life (2000, Insight Media, 24 minutes). Assisted Reproductive Technology (ART) and ethical/social issues discussed, including a section on use of microscopic technology in infertility treatments.

Gift of a Girl (1998, Filmmakers Library, 24 minutes). Examines the practice of female infanticide in India (resulting from dowry rules) and the attempts to eradicate it.

Women of the Yellow Earth (1996, Filmmakers Library, 50 minutes). Profile of two women in rural China, one who is having trouble with planning officials because she is about to have her third child, and the other who is planning her wedding.

Invasion of the Embryo (no year, Films for the Humanities and Social Sciences, 25 minutes). Discovery Channel Production from Body Story series – follows prenatal development from a fertilized egg to the newborn as a couple conceives a child and experience pregnancy and childbirth.

Prenatal Development: A Life in the Making (1996, Insight Media, 26 minutes). Full presentation of prenatal development, including stages, reproductive structures and functions, and environmental influences on the embryo and fetus.

Sex Hormones and Sexual Destiny (no year, Films for the Humanities and Social Sciences, 26 minutes). Examines effects of hormone levels on gender specific behaviors.

Prenatal Development (2001, Films for the Humanities and Social Sciences, 21 minutes). Presentation of the milestones of prenatal development, and emphasizes the importance of prenatal care by examination of relations between maternal health and nutrition and normal development.

Cells: Baby and Child (no year, Films for the Humanities and Social Sciences, 51 minutes). The first segment of this video shows the use of microscopic imaging techniques to examine cells as the “building blocks of life” in prenatal development.

KEY TERMS

Genetics	Phenotype
Chromosomes	Autism
Gene	Conception
Polygenic	Endometrium
Deoxyribonucleic acid (DNA)	Motility
Mitosis	Pelvic inflammatory disease (PID)
Mutation	Endometriosis
Meiosis	Artificial insemination
Autosome	In vitro fertilization (IVF)
Sex chromosome	Donor IVF
Monozygotic (MZ) twins	Germinal stage
Dizygotic (DZ) twins	Blastocyst
Ovulation	Embryonic disk
Allele	Trophoblast
Homozygous	Umbilical cord
Heterozygous	Placenta
Dominant trait	Embryonic stage
Recessive trait	Cephalocaudal
Carrier	Proximodistal
Multifactorial problems	Ectoderm
Down's syndrome	Neural tube
Sex-linked chromosomal abnormalities	Endoderm
Klinefelter syndrome	Mesoderm
Testosterone	Androgens
Turner syndrome	Amniotic sac
Estrogen	Amniotic fluid
Phenylketonuria (PKU)	Placenta
Huntington's disease	Fetal stage
Sickle-cell anemia	Stillbirth
Tay-Sachs disease	Teratogens
Cystic fibrosis	Critical period
Hemophilia	Syphilis
Sex-linked genetic abnormalities	Congenital
Muscular dystrophy	HIV/AIDS
Genetic counselors	Rubella
Prenatal	Preeclampsia/Toxemia
Amniocentesis	Premature
Miscarriage	Rh incompatibility
Chorionic villus sampling (CVS)	Thalidomide
Uterus	Progestin
Ultrasound	DES
Sonogram	Fetal alcohol syndrome (FAS)
Alpha-fetoprotein (AFP) assay	
Genotype	