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CHAPTER 2: GENETICS AND PRENATAL DEVELOPMENT

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LEARNING OBJECTIVES

Section 1: Learning Objectives

2.1 Distinguish between genotype and phenotype and identify the different forms of genetic inheritance.

2.2 Describe the sex chromosomes and identify what makes them different from other chromosomes.

2.3 Explain how behavior geneticists use heritability estimates and concordance rates in their research.

2.4 Describe how the concept of *epigenesis* frames gene–environment interactions, and connect epigenesis to the concept of *reaction range*.

2.5 Explain how the theory of genotype → environment effects casts new light on the old nature–nurture debate.

2.6 Outline the process of meiosis in the formation of reproductive cells.

2.7 Describe the process of fertilization and conception.

2.8 List the major causes of and treatments for infertility, and describe how infertility is viewed in different cultures.

Section 2: Learning Objectives

2.9 Describe the structures that form during the germinal period.

2.10 Outline the major milestones of the embryonic period.

2.11 Describe the major milestones of the fetal period, and identify when viability occurs.

2.12 Compare and contrast prenatal care in traditional cultures and developed countries.

2.13 Identify the major teratogens in developing countries and developed countries.

Section 3: Learning Objectives

2.14 Explain how chromosomal disorders occur.

2.15 Describe the causes and symptoms of some common genetic disorders.

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2.16 Describe the three main techniques of prenatal diagnosis.

2.17 Explain who is likely to seek genetic counseling and for what purposes.

KEY TERMS

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chromosome p. 50
DNA (deoxyribonucleic acid) p. 50
gene p. 50
genome p. 50
genotype p. 50
phenotype p. 50
dominant–recessive inheritance p. 51
allele p. 51
polygenic inheritance p. 52
sex chromosomes p. 52
X-linked inheritance p. 53
nature–nurture debate p. 53
behavior genetics p. 54
monozygotic (MZ) twins p. 54
dizygotic (DZ) twins p. 54
heritability p. 54
concordance rate p. 54
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theory of genotype → environment effects p. 56
passive genotype → environment effects p. 57
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mitosis p. 59
gametes p. 60
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follicle p. 61

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zygote p. 62
infertility p. 62
assisted reproductive technologies (ART) p. 63
artificial insemination p. 63
in vitro fertilization (IVF) p. 64

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blastocyst p. 67
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embryonic disk p. 67
amnion p. 67
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umbilical cord p. 67
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ectoderm p. 68
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teratogen p. 72
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Fetal alcohol spectrum disorder (FASD) p. 75

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incomplete dominance p. 79
ultrasound p. 80
amniocentesis p. 80
chorionic villus sampling (CVS) p. 81

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LECTURE NOTES

I. Section 1: Genetic Influences on Development

A. Genetic Influences on Development: Genetic Basics

1. Genotype and Phenotype

   a. There are 46 **chromosomes** in the human **genome**, organized into 23 pairs which are composed of **DNA**. Our DNA is organized into about 23,000 segments called **genes**, or units, of hereditary information.

   b. The totality of an individual's genes is the **genotype**, and the person's actual characteristics are called the **phenotype**.

   c. Genotype and phenotype may vary due to dominant–recessive inheritance, incomplete dominance, and environmental influences.

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i. **Dominant-recessive** inheritance means that only the *dominant gene* influences the phenotype, while the *recessive gene* does not. Each form of the gene is called an allele.

ii. **Incomplete dominance** exists when the phenotype is influenced primarily by the dominant gene, but not entirely.

a.Sickle cell trait result of incomplete dominance.

d. Most human characteristics are the result of **polygenic inheritance**, meaning that they are influenced by multiple genes, rather than just one.

2. The Sex Chromosomes

a. Among the 23 pairs of chromosomes, one pair is different from the rest, the sex chromosomes.

b. These sex chromosomes determine whether the person will be male or female.

c. In the female, this pair is called XX; in the male, XY.

i. All eggs from the female donate only an X chromosome.

ii. Males will donate either an X or Y chromosome to the pairing, ultimately determining the sex of the child.

iii. Beliefs about how to predict a baby's sex vary by culture. There are unscientific examples from Mayan and Chinese cultures. Strong preference for boys in many cultures.

d. The biological consequences of having only one X chromosome makes males more vulnerable than females to a variety of recessive disorders that are linked to the X chromosome, referred to as **X-linked inheritance**.

B. Genetic Influences on Development: Genes and the Environment

a. The **nature versus nurture debate** is the battle between genetics or the environment as the explanation for development. Currently, it is agreed that both play a role, but the amount of influence from each is still debated.

1. Principles of Behavior Genetics

a. **Behavior genetics** involves the study of how genes contribute to human development, especially focusing on the heritability of various characteristics and concordance rates between people with different degrees of genetic similarity.

b. Identical or **monozygotic (MZ) twins** have 100% of their genes in common (including sex genes), while fraternal or **dizygotic (DZ) twins** and siblings have 40–60% of their genes in common.

c. **Heritability** is an estimate of the extent to which genes are responsible for individual differences, ranging from 0 to 1.00. Higher heritability may indicate more genetic influence.

d. Heritability estimates also measure how much the environment allows genes to be expressed, thus measuring phenotype.

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e. The **concordance rate** indicates the degree of similarity in phenotype among pairs of family members from 0 to 100 percent.

2. Gene-Environment Interactions: Epigenesis and Reaction Ranges

a. The environment does influence gene expression; the resulting developmental process, **epigenesis**, is created from the bi-directional interactions between genotype and the environment.

b. Genes establish a **reaction range** of possible developmental paths established by genes; environment determines where development takes place within that range.

3. The Theory of Genotype→Environment Effects

Scar and McCartney developed a theory of genotype and environment effects that note that both make essential contributions, but that we create our own environments based on our genotypes.

a. The Three Forms of Genotype→ Environment Effects

i. Genes influence environments through three types of genotype-environment effects.

a) **Passive-genotype →environment effects:** Parents provide both genes and environment to their children.

b) **Evocative-genotype →environment effects:** Children evoke responses from those who care for them.

c) **Active-genotype →environment effects:** Children seek out an environment that corresponds to their genotype, known as *niche-picking*.

b. Genotype →Environment Effects Over Time

ii. The three types of effects operate throughout the life span and their relative balance changes with time based on how much control individuals have over their environment.

C. Genetic Influences on Development: Genes and Individual Development

1. Sperm and Egg Formation

a. **Gametes**, or reproductive cells, are called **sperm** in the male and **ovum** (egg) in the female. Their formation is referred to as **meiosis**.

b. In meiosis, cells that begin with 23 pairs of chromosomes split and replicate repeatedly until they form four gametes, each with 23 individual chromosomes.

i. In males, the outcome of completed meiosis is four viable sperm.

ii. In females, meiosis produces only one viable ovum, but the process is not completed until the ovum is fertilized. The viable ovum stores **cytoplasm**, which is the main source of nutrients immediately following conception.

iii. **Crossing over** is a process whereby genetic material from the parents is mixed, resulting in sibling differences.

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c. Males produce millions of sperm each day (100–300 million per ejaculation), but females have all of the ova they will ever have while still in utero (about 1 million).

2. Conception

   a. Conception generally begins with sexual intercourse between a man and woman. Sperm must travel a long distance to make it to the ovum and only a few hundred survive the difficult journey.

      i. Each ovary alternates monthly with an ovum release.

      ii. A **follicle** consists of the ovum and the supporting cells.

      iii. About 14 days into a woman's cycle, an ovum is released into the fallopian tube from one of the ovaries.

   b. Only during the 24 hours following the ovum release can fertilization occur, so conception is most likely to take place on the day of intercourse or up to 48 hours before.

   c. A new cell, the **zygote**, is formed from the two gametes.

   d. The zygote's 46 paired chromosomes constitute the new organism's unique genotype, set once and for all at the moment of conception.

   e. Variations in the process and conditions can result in twins.

3. Infertility

   Infertility is diagnosed when a couple has been unable to attain pregnancy after at least a year of regular intercourse without contraception. U.S. infertility rates are consistently 10–15% among couples.

      a. Sources of Infertility

         i. Half of the time the source of infertility is from the male and half from the female.

         ii. Male infertility may be caused by too few sperm being produced; the poor quality of the sperm; or the sperm may be low in motility.

         iii. Female infertility is most often caused by problems in ovulation.

         iv. Infertility in both men and women is often due to age, but it can also be genetic or caused by behavior such as drug abuse, alcohol abuse, or cigarette smoking.

      b. Infertility Treatments

         i. The overarching term for the methods used to achieve pregnancy when natural conception is not possible is called **Assisted Reproductive Technologies (ART)**.

         ii. **Artificial insemination** is when the man's sperm, typically from a donor, is injected directly into the woman's uterus.

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a) Often used from donor insemination for couples with sperm production problems and by lesbian couples or single women who want a child.

b) It is a simple, effective, and cost-efficient procedure with a 70% + success rate.

iii. Fertility drugs are commonly used when the woman has ovulation problems. They are used to control hormone levels to stimulate the quality and quantity of follicles in each cycle.

iv. Yields more than a 50% success rate after 6 months or cycles.

v. Risks include blood clots, kidney and ovarian damage, and the likelihood of multiple follicles being produced. Multiple births occur in 10–25% of mothers and carry risks such as miscarriage, premature birth, and developmental delays.

c. In-Vitro Fertilization (IVF)

i. This method is used when other attempts have been unsuccessful.

ii. Ova are harvested and combined with sperm for fertilization and implantation.

iii. The success rate ranges from 40% for women younger than 35 years, 22% for women ages 38–40, to 4% in women over 41.

d. Infertility Worldwide

i. Cultural differences exist in how infertility is viewed and treated socially.

ii. In individualistic cultures, infertility results in frustration, sadness, and loss.

iii. Infertility is deeply stigmatizing and viewed as more serious and devastating in collectivistic cultures where there is limited access to ART. It may be cause for divorce or taking another wife in these cultures.

II. Section 2: Prenatal Development and Prenatal Care

A. Prenatal Development and Prenatal Care: Prenatal Development

1. The Germinal Period (First 2 Weeks)

a. During the germinal period, the zygote travels down the fallopian tube, and cellular division begins. The result is a ball of about 100 cells called the blastocyst, which has two layers.

i. The trophoblast, or outer layer, will form the supporting structures of the amnion, placenta, and umbilical cord.

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ii. The embryonic disk that will become the embryo of the new organism is the inner layer.

b. During Week 2, implantation occurs, and a protective, fluid-filled membrane, the amnion, forms around the trophoblast. The nutrient transmitting placenta forms between the uterus and the embryonic disk, and the umbilical cord begins to develop.

c. Only about half of all implantations are successful. If implantation fails, then the uterine lining will shed during the women's next menstrual period.

2. The Embryonic Period (Weeks 3–8)

a. During this period of gestation (the time elapsed since conception), nearly all the major organ systems are formed initially.

b. The embryonic disk differentiates into 3 layers.

i. The outer layer known as the ectoderm; the middle layer, or mesoderm; and the endoderm, or inner layer.

ii. The neural tube, which later becomes the spinal cord and brain, develops first and fastest.

iii. Billions of neurons or nerve cells are produced by the neural tube.

c. The heart begins beating during Week 4.

d. By the end of the 8th week, the embryo is about an inch long; all main body parts and organs have formed, except for the sex organs. It looks like a human.

3. The Fetal Period (Week 9–Birth)

a. During the fetal period (9 weeks after conception to birth), organ systems continue to develop, and there is immense growth in size.

b. This period is divided into 3 three-month periods called trimesters.

i. By the end of the third month, the genitals have formed, and the fetus weighs 3 ounces and is 3 inches long ("3 times 3").

ii. During the second trimester, the fetus becomes more active and responsive, which is felt by the mother at 4 months. It is covered with a slimy, white substance called the vernix and downy hair called lanugo. By the end of the second trimester or 6 months, it weighs 2 pounds and is 14 inches long.

iii. Viability, the ability to survive outside the womb, is rare before the third trimester because of the immaturity of the lungs. Survival before 22 weeks is rare and only 50% by 26 weeks, and those who do survive tend to have disabilities.

iv. Best chance for those in developed countries or those with access to advanced medical care.

v. During the third trimester, the fetus experiences rapid brain development during the last two months.

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vi. The brain is still very immature at birth compared to other animals, making the neonate more dependent on parental care.

c. The brain is still very immature at birth compared to other animals.

d. By 28 weeks, the fetus has sleep-wake cycles similar to a newborn baby and can remember and respond to sound, taste, and the mother's movements.

B. Prenatal Development and Prenatal Care: Prenatal Care

1. Variations in Prenatal Care

a. Some pregnancy advice is practical and sensible based on the collected wisdom of the culture over time. Some advice may seem odd to those from other cultures, particularly when it is not scientifically based.

i. The Beng people of Africa have women avoid wine based on bad outcomes, but are also told not to eat antelope or they could have striped babies.

ii. In Bali, pregnant women are to avoid hot foods among other things and to avoid those who are spiritually impure.

b. These prenatal customs may emerge from an awareness that pregnancy and childbirth can be life threatening to the mother and fetus and a desire for a successful outcome.

c. In developed countries, prenatal care has come a long way in recent decades. Previously, women were instructed to limit weight gain during pregnancy, but now they are told to gain 25–35 pounds, with women who gain less than 20 pounds or too much weight experiencing more complications.

d. Pregnant women should receive regular prenatal care from a skilled health care worker, such as a physician, nurse, or midwife. This is more likely in developed countries, but some poorer regions may not have access.

e. Prenatal care focuses on diet, exercise, and avoiding teratogens.

2. Teratogens

A teratogen is a behavior, environment, or bodily condition that can have damaging influence on prenatal development.

a. Vulnerability to teratogens varies based on the age of the organism at the time of exposure, known as the *critical period*. The embryonic period is an especially critical period of development.

b. Malnutrition

i. Malnutrition is the most common teratogen in the world.

ii. Lack of financial means to buy food and varying availability are major contributors to malnutrition.

iii. Nutritional deficiencies can lead to prenatal disorders. Lack of folic acid has been shown to cause *anencephaly* or *spina bifida.*

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iv. Folic acid is so important that governments have begun requiring supplements be added to foods, especially grain products. Ideally, women should begin taking folic acid when they start trying to get pregnant.

v. Iron and iodine are two other common nutritional deficiencies, but is remedied with the right foods and supplements.

vi. Poor prenatal nutrition can contribute to prenatal problems such as premature delivery and low birth weight and physical and mental health problems later in life.

c. Infectious Diseases

i. Infectious diseases are most common in developing countries with limited access to vaccinations.

ii. *Rubella*, or German measles, is a serious disease that when contracted by the mother is a teratogen during the embryonic period.

a) It can render embryos blind and deaf, with cognitive and physical deficits.

b) Fetal effects of rubella can include low birth weight, hearing problems, and skeletal defects.

iii. AIDS is a sexually transmitted infection (STI) caused by HIV that damages the immune system.

a) HIV/AIDS can be passed from mother to child.

b) The likelihood of contracting it can be reduced by giving pregnant mothers, and later the infant, effective medications, delivering by c-section, and using infant formula.

iv. Alcohol is the most prevalent and damaging teratogen in developed countries.

a) A safe amount of alcohol while pregnant is *none at all*! Even small amounts can compromise the child's prenatal development.

b) Fetal alcohol spectrum disorder (FASD) occurs when mothers drink heavily during their pregnancies. It can cause severe birth defects and cognitive deficits.

v. Nicotine from smoking is the leading cause of low birth weight in developed countries.

a) Pregnant women who smoke put themselves and their fetuses at risk for miscarriage, premature birth, and low birth weight.

b) The child's later development is also compromised from maternal cigarette smoking. Negative outcomes, such as poor health, cognitive impairment, and behavior problems are increased.

c) Exposure to secondhand smoke is also problematic.

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vi. Illegal, prescription, and non-prescription drugs are also known potential teratogens that can cause physical, cognitive, and behavioral problems in infants.

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III. Section 3: Pregnancy Problems

A. Pregnancy Problems: Chromosomal and Genetic Disorders

1. Chromosomal Disorders
    a. Sex Chromosome Disorders
        i. These disorders are commonly involved in chromosomal disorders in which a person may have an extra X or Y chromosome, or may be missing one.
        ii. Two common consequences include cognitive deficits and an abnormal reproductive system.
    b. Down Syndrome or Trisomy-21
        i. This disorder occurs when there is an extra chromosome on the 21st pair.
        ii. It is marked by distinct physical features, such as short, stocky build, flat face, large tongue, and an extra fold of skin on the eyelids.
        iii. Cognitive and physical deficits are also prevalent.
        iv. Social development varies widely and can be fostered by supportive families and intervention programs.
        v. Those with Down syndrome have lower life expectancy than the general population.
    c. Parental Age and Chromosomal Disorders
        i. Chromosomal disorders most commonly occur to mothers of advanced maternal age.
        ii. The risk climbs over time, low for mothers in their 20s, rises in the 30s, but steeply rises over 40 and beyond.

2. Genetic Disorders
    a. Genetic disorders may be caused by incomplete dominance or by mutations.
    b. Incomplete dominance is a form of dominant-recessive inheritance in which the phenotype is influenced primarily by the dominant gene, but also to some extent by the recessive gene.
    c. One example is sickle-cell anemia, common among black Africans and their descendants, but also Indians and those from the Mediterranean region.
    d. Other common genetic disorders caused by mutations include fragile X syndrome and phenylketonuria (PKU).

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B. Pregnancy Problems: Testing and Counseling Options

1. Prenatal Diagnosis
    a. Developed countries are likely to have access to techniques to monitor the growth and health of the fetus and to detect problems.
    b. Common techniques include ultrasound, amniocentesis, and chorionic villus sampling (CVS).
        i. Ultrasounds may be performed throughout pregnancy with no risk to the fetus. High-frequency sound waves are directed toward and bounce off of the mother's abdomen, producing a computer image. It is used to measure fetal size, shape, and activities and to screen for chromosomal disorders and determine the sex of the child.
        ii. Amniocentesis is the extraction of amniotic fluid using a long, hollow needle to analyze fetal cells from the placenta, allowing possible prenatal problems to be detected.
            a) It is usually conducted at 15–20 weeks' gestation for women 35 years and older or those with a family history of problems.
            b) Small risk of triggering a miscarriage.
            c) Very accurate in detecting 40 different fetal defects.
        iii. In CVS, a sample of forming umbilical cord cells is taken at 5–10 weeks' gestation for analysis of genetic materials.
            a) CVS carries risks similar to an amniocentesis.
            b) Used with women who are 35 years old and above, as well as those with a family history of genetic abnormalities.
2. Genetic Counseling
    a. Genetic counseling involves analyzing the family history and genotypes of prospective parents to identify possible risks of having children with genetic disorders.
    b. Making the decision to get genetic counseling can be difficult, but those who proceed can make informed decisions.

LECTURE LAUNCHERS, DISCUSSIONS, AND ACTIVITIES

Section 1 Activity and Discussion: The Human Genome Project

Many of your students will have heard of the Human Genome Project (HGP), but they might not understand what it is. This activity is designed to extend the information from the textbook on p. 48 on the Human Genome Project. The two primary goals of the project were to identify all of the approximately 23,000 genes in human DNA and to determine the sequences of the three billion chemical base pairs that make up human DNA. Have students visit the Human Genome Project website to learn more about the history of the project, the goals, and the applications of the findings thus far. Then discuss the merits of the HGP. What should be done with this

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information? Do the students believe that the high cost of the project ($3 billion over fifteen years) was justified?

http://web.ornl.gov/sci/techresources/Human_Genome/project/index.shtml

Section 1 Discussion: Gene-Environment Interaction

You might ask the students to speculate on possible outcomes for a child with a high genetic endowment for IQ born into an environment that is not intellectually rich. One possibility they might come up with is that the child will seek out environments that are more suitable for his genetic tendency (e.g., spending time in the library). This "niche picking" is an example of why there is an interaction between genes and environment. Another way to elaborate on this issue is to point out that the heritability of some traits, such as general cognitive ability or antisocial behavior, tends to increase with age (Goldsmith & Gottesman, 1996; Plomin et al., 1997). Challenge students to speculate on why this might be. One possible explanation is that genetic tendencies encourage the individual to seek out environments (e.g., peer groups) that foster the development of those traits. What other explanations can students come up with?

Section 1 Lecture Launcher: Infertility

"Infertility is defined as the inability to get pregnant after one year or more of regular sexual activity without the use of contraception, or the inability to carry a pregnancy to a live birth…. Some specialists use two years as the cutoff point" (Jewelewicz, 1989, p. 170). Contrary to popular opinion, infertility rates are not on the rise. In 1965, the United States infertility rate was 13.3%; in 1988 it was 13.7%. However, estimates are that one-sixth of all couples who try to conceive are sterile or infertile. Jewelewicz (1989) cites several reasons for this:

- There are more couples trying to conceive because the post-WWII baby boomers are reaching the end of their reproductive years.
- The rise in sexually transmitted diseases, women entering the workforce and being exposed to occupational hazards that affect their fertility, and the possibility of being exposed to more environmental toxins are all reasons hypothesized for increased infertility.
- Women are delaying childbirth, and increased age is related to decreased fertility.
- Oral contraceptives and use of an IUD may account for some cases of infertility.
- Because of second marriages, some couples seek to reverse previous surgical sterilizations.
- More techniques are available and written about in the media, so couples are more aware of help for infertility.

It is estimated that over three million couples will seek reproductive help each year. The top five procedures include the following:

- in vitro fertilization (IVF)
- gamete intrafallopian transfers (GIFT)
- intrauterine insemination (IUI)
- zygote intrafallopian transfer (ZIFT)
- intracytoplasmic sperm injection (ICSI)

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There are some pros and cons about the new reproductive technologies. For example, before the 1970s, only *donor insemination*—injection of sperm from an anonymous man into a woman—was available for infertile women. Today, *in vitro fertilization* is a common choice where hormones are used to stimulate the production of several ova, which are removed. The eggs are placed in a dish of nutrients, sperm are added, and then the fertilized eggs are injected into the mother. Ova can be screened for genetic defects, and fertilized ova can also be frozen for use in the future. Sperm can also be frozen. Few states have legal guidelines for these procedures. Consequently, problems that might arise include the following:

- genetic defects
- sexually transmitted diseases
- poor records of donor characteristics
- possibility that children from same donor may grow up together and marry
- use of genetic selection for the "perfect child"
- use of "surrogate mothers"

Sources:

Jewelewicz, R. (1989). Sexual and reproductive health. In Tapley, D. F., Morris, T. Q., Rowland, L. P., Weiss, R. J., Subak-Sharpe, G. J., & Goetz, D. M. (Eds.), *The Columbia University College of Physicians and Surgeons complete home medical guide* (rev. ed.). New York: Crown.

Rutter, V. (March/April, 1996). Who stole fertility? *Psychology Today*, 46–47, 65–70.

Use Handout 2-1 to review some reasons for infertility and various solutions.

Section 1 Discussion: Ethics of Assisted Reproductive Technology

Fertility and conception have changed drastically in the last several decades as medical interventions to enhance fertility and to assist in conceiving a child have become much more common. There are many ethical issues that are relevant to this topic. Recently, the pregnancy of Nadya "Octomom" Suleman brought this issue to the forefront of the news once again. Ms. Suleman was a single, unemployed mother of 6 children and used assisted reproductive technology to get pregnant again. She gave birth to octuplets. She now has 14 children. This case, and others like it, has caused much debate. For example, should a woman with such limited resources be allowed to use ART? Is it ethically defensible for a mother to choose not to selectively reduce the number of fetuses? What if there were serious developmental risks to the fetuses? What if there were serious health risks to the mother? What if the family will be unable to care for the children after they are born? There are other issues related to assisted reproductive technology as well. For example, with ART it is possible for considerably older women to have children. Are there any ethical objections to this?

Section 1 Activity: Infertility and Assisted Reproductive Technology

Have students investigate what medical options currently exist for people who are unable to conceive children naturally. What are the success rates of these options? What are the costs of these options? What are the risks? You might suggest that they focus on the more common treatments (e.g., hormone treatments, IVF) rather than the more exotic (GIFT, ZIFT).

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Section 2 Activity: Life's Greatest Miracle

"Life's Greatest Miracle" (53:41) is a video that originally aired on November 20, 2001 on PBS. Have students watch this video online or in class; it comes with a complete transcript as well for your hearing impaired students. This is an excellent video detailing the process of conception through birth. It is an excellent visual review of Chapter 2 Section 2–3 and Chapter 3 Section 1. http://www.pbs.org/wgbh/nova/body/life-greatest-miracle.html

Section 2 Activity: Podcast on Improving Maternal Health

Mental health podcast (11:45). The United Nations created millennium goals in 2000. One of these goals included improving maternal health in developing countries. In fact, their goal was for maternal health care to become a universal right by the year 2015. In the podcast, the president of the International Women's Health Coalition, Adrienne Germain, is interviewed. She notes the importance of addressing this issue in developing countries using a holistic approach of prevention and intervention beyond medical care to include societal problems of poverty, malnutrition, and women's rights.

http://www.pbs.org/wgbh/nova/body/maternal-germain-au.html

More detailed information on this and other related Millennium Development goals is available on the UNICEF website at http://www.unicef.org/mdg/maternal.html.

Section 3 Discussion: Genetic Testing

The recent explosion of knowledge about genetics raises many interesting practical and ethical questions about genetic testing. Initiate a discussion about the pros and cons of such testing. Do the students believe that people should be tested to determine their susceptibility to certain diseases? When should this testing be done? At birth? Prenatally? Should parents be allowed to test their unborn children for the presence or absence of certain traits? Should they be allowed to make decisions about continuing the pregnancy on the basis of the results? If one member of a family discovers through genetic testing that she or he is susceptible to certain genetic disorders, is that person obligated to let other family members (who might share that susceptibility) know? Who should have access to this information? Health insurance companies? Potential employers?

Section 3 Activity: Genetic Counseling

A series of case studies can be an excellent way to explore the scientific and ethical issues surrounding genetic counseling. Have students work in teams to discuss how they would counsel various couples who might talk to a counselor. What questions would be important to ask? What advice might they give? What emotions might be likely to come up? Some examples of case studies might include the following:

- A couple who has just learned that a prenatal screening test (e.g., the alphafetoprotein test) has yielded an abnormal result
- A couple who has not yet conceived a child, but who has a history of Tay-Sachs disease in the wife's family

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- An unmarried woman who is 39 years old who wishes to have a child through artificial insemination
- An African American couple who is expecting a baby. They have no history of sickle-cell anemia in the family, but they are concerned about the possibility of this disorder for their child.
- A couple with four sons who desperately want a daughter. They are planning a fifth pregnancy.

CRITICAL THINKING ABOUT DEVELOPMENT

Evaluating Websites for Academic Use

Understanding the Concept

In a world bombarded with information, who can keep up with where we heard it, who said it, or whether there was valid evidence supporting it? No one can fact check everything in life.

As a student and a member of the academic community, however, you must adopt a different attitude about sources of information. The Internet is a wonderful resource and a minefield of misinformation. Evaluating websites is critical to academic and professional success today.

Critical Thinking Challenge, Website Evaluation

1. Use a search engine to locate two different websites with information on prenatal development or care. One website must be a ".gov," or ".edu" address. One must be a ".net" or ".com" address. Use the following table of basic questions to evaluate and compare them. Circle their score on each factor.

Record the web address and name of the websites:	(.gov or .edu)	(.net or .com)
Name the owner of the website and give their contact information (not the webmaster).	+1 if it is there.	+1 if it is there.
Identify the funding source.	+1 if it is there.	+1 if it is there.
Name the editor or editors.	+1 if it is there.	+1 if it is there.
Authors are named.	( ) yes ( ) no ( ) some +2 +0 +.5	( ) yes ( ) no ( ) some +2 +0 +.5
Information includes date submitted or last updated.	( ) yes ( ) no ( ) some +2 +0 +.5	( ) yes ( ) no ( ) some +2 +0 +.5
The purpose, goals, or mission of the site are stated clearly.	( ) yes +2 ( ) no +0	( ) yes +2 ( ) no +0

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The sources of the information provided are given.	( ) yes +2 ( ) no +0	( ) yes +2 ( ) no +0
The sources used are credible, from experts in the field and the scientific process.	( ) yes +2 ( ) no +0	( ) yes +2 ( ) no +0
Opinion is clearly identified as such.	( ) yes +2 ( ) no +0	( ) yes +2 ( ) no +0
The site has an identifiable, but not directly stated, bias or secondary agenda.	( ) yes -2 ( ) no +2 If yes, describe:	( ) yes -2 ( ) no +2 If yes, describe:
The site advertises products related to content.	( ) yes -2 ( ) no	( ) yes -2 ( ) no
Total Points		

2. If you could not find out who owns or sponsors a website or you can't find their contact information, go to http://www.easywhois.com to find who owns the domain name and how to contact them. Record the information here:

3. Summarize in writing the differences, weaknesses, and strengths for academic use of each website you chose.

Instructor's Guide to Critical Thinking about Development

This exercise works well as an individual assignment followed by class or small group discussion if time allows. You may wish to preselect websites to maximize the differences between academically appropriate and inappropriate websites. (Although what students find can be quite astounding!)

The exercise transfers most easily to online discussion by preselecting the websites for a forum, having students use the table as a guide, and then submit their written summary and comments in the discussion. Several websites can be covered if you use small group discussions in your course.

In the lecture hall, students can be given the table, with each website projected for a period of time while they attempt to do the analysis. This makes a good, brief, hands-on experience to accompany a lecture on evaluating sources.

Additional Resources

http://www.vtstutorials.ac.uk/ Free Internet tutorials to help students develop research skills at the university level from lecturers and librarians in the United Kingdom. "Internet Detective" covers academic standards, evaluating websites, and plagiarism.

Fact check hoaxes, urban myths, chain e-mail, and political statements at these sites:

www.snopes.com

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www.hoax-slayer.com

www.factcheck.org

SUPPLEMENTAL READINGS

American Baby Magazine (1995). As your baby grows, 4(2).

This magazine is published for expectant mothers and fathers and uses some of Nilsson's photographs to describe how the fetus develops month by month. To obtain a copy, write to Cahners Publishing Company, 249 West 17th Street, New York, NY 10011 or call (212) 645-0067.

Dorris, M. (1990). *The broken cord.* New York: HarperCollins.

This is a moving account of the difficulty an adoptive father has raising his son born with fetal alcohol syndrome.

Eisenberg, A., Murkoff, H. E., & Hathaway, S. E. (1991). *What to expect when you're expecting* (rev. 2nd Ed.). New York: Workman.

This is an excellent and comprehensive guide that covers conception, pregnancy month by month, and childbirth.

Freiberg, K. L. (Ed.). (2002). *Annual editions: Human development 2002/2003* (30th Ed.) Guilford, CT: Dushkin/McGraw-Hill.

A State of the Art Pregnancy and *Fetal Psychology* provide additional information on the importance of a healthy prenatal environment.

Nilsson, L., Ingelman-Sundberg, A., & Wirsen, C. (1990). *A child is born* (2nd Ed.). New York: Delacorte Press.

Lennart Nilsson is justly famous for his amazing photographs of babies in utero. Share these with your class. The film *The Miracle of Life* also uses some of his microphotography. As one student exclaimed, "He must be a very small photographer!"

MULTIMEDIA IDEAS

Biological Growth: Nature's Child (Insight Media, 1991, 60 minutes)

Explores the nature-nurture controversy. Examines the influences of genetics on behavior, concentrating on hereditary contributions to intelligence, temperament, personality, sex differences, and mental illness. It also investigates the influence of environment on prenatal development.

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Birth Defects (Films for the Humanities and Sciences, 1987, 19 minutes)

Describes both genetic and environmental causes of birth defects.

Brave New Babies (Penn State Audio-Visual Services, 1982, 48 minutes)

An introduction to genetic engineering.

Developmental Phases Before and After Birth (Films for the Humanities and Sciences, 28 minutes)

This program examines the development of the fetus in utero and the child during the first year.

Fetal Alcohol Syndrome and Other Drug Use During Pregnancy (Films for the Humanities and Sciences, 19 minutes)

This program profiles an 8-year-old boy born with FAS, showing how alcohol enters the bloodstream of the fetus; it describes common characteristics of children with FAS and the learning disabilities, mental handicaps, and behavioral problems that are common. Also shows how cocaine impairs the growing fetus.

Heredity and Environment (Insight Media, 1988, 30 minutes)

Describes the basic mechanisms of heredity and discusses the joint role of heredity and environment in determining human characteristics and development.

High Tech Babies (Coronet/MTI Film and Video, 1987, 58 minutes)

Useful as a way of increasing students' awareness of the issues surrounding the new reproductive technology: in vitro fertilization.

The Miracle of Life (Time-Life Films, 1983, 57 minutes)

Shows development from conception to birth using Nilsson's microphotography techniques. Actually presents footage of the fetus moving in utero.

Motherhood on Hold (Films for the Humanities and Sciences, 23 minutes)

In this program, a reproductive endocrinologist explains why a woman's chances of conceiving drop dramatically after the 20s, and four women discuss their own very different experiences in trying to have children and the factors that shaped their choices in determining when to conceive.

Pregnancy and Substance Abuse (Films for the Humanities and Sciences, 28 minutes)

This program follows several couples through pregnancy and prenatal care. Former US Surgeon General C. Everett Koop talks about the risks of smoking; and Michael Dorris, author of *The Broken Cord*, discusses his life raising an adopted son with fetal alcohol syndrome. Highly recommended.

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Prenatal Development (Insight Films, 1979, 30 minutes)

Describes development from conception to birth. Illustrates the effects of cigarette smoking, alcohol, and drug use on a developing fetus. Shows fetal responsiveness to foods ingested by the mother and to music. Shows a birth at the end.

Prenatal Diagnosis (Filmmakers Library, 1982, 45 minutes)

Explains amniocentesis, fetoscopy, and ultrasound. Discusses the ethical and practical aspects of making a decision about whether to abort or not abort an abnormal fetus.

Psychological Development Before Birth (Films for the Humanities and Sciences, 22 minutes)

The development of the individual can be followed in utero. This program shows how it is possible to determine the well-being of the fetus; when the fetus begins to react to sound; and how mothers-to-be deal with pregnancy and prepare themselves for the birth.

TEXTBOOK FEATURES

Video Guide

a. Genetics and Prenatal Development (8:56; p. 49)
b. A Preference for Sons (4:07; p. 52)
c. Epigenetics (3:09; p. 56)
d. Research Focus: Twin Studies: The Story of Oskar and Jack (3:59; p. 58)
e. Cultural Focus: Pregnancy and Prenatal Care across Cultures (8:22; p. 72)
f. Career Focus: Genetic Counselor (5:11; p. 82)

Critical Thinking Questions and Answers

Think of one of your abilities and describe how the various types of genotype → environment effects may have been involved in your development of that ability. (p. 59)

Examples might include intelligence, musical ability, athletic ability, talents such as dance, and the like. We know that intelligence is partly heritable, but the genes must interact with the environment—parents, school, books—in order to develop its potential. Likewise, some aspects of musical ability may be heritable, but again, if a student was never introduced to a musical instrument, he would never know he might one day become a musician.

Are there any beliefs in your culture about what a woman should eat or should avoid eating before or during pregnancy? Do the same beliefs apply to men during any point of the conception and gestation continuum? (p. 71)

This will vary by cultural group, but many American women are told they should not eat deli meats, soft cheese, undercooked meat, poultry, pork, fish with mercury, raw shellfish, raw eggs,

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unpasteurized milk or milk products, coffee or other sources of caffeine, alcohol, and unwashed produce. Men should avoid high-fat, high-calorie foods like fast food in order to protect sperm and produce viable sperm that can swim fast. Obesity for both men and women is a factor in fertility.

Do you think that genetic counseling will increase or decrease in the next 10 years? Provide reasons for your answer from an ecocultural point of view. (p. 81)

As the field of genetics continues to develop, genetic counseling will increase in the next 10 years. The ecocultural theory emphasizes the ecological and cultural aspects of development. Answers will vary. One example response follows: Families have greater access to health care, and genetic counseling is more widely socially accepted than in previous years. As a result, they may be more likely to use genetic counseling.

Research Focus Answers

Twin Studies: The Story of Oskar and Jack (p. 58–59)

1. d
2. c

Cultural Focus Question and Answer

What are the advantages of using a doctor or of using a midwife, as described in this video clip? What others can you think of?

The role of the midwife from this video is to provide, quite literally, a hands-on experience to the expectant mothers. She discusses that she checks the baby with her hands and massages to help maintain a good position. She can reposition the baby if it is not in the appropriate position. She also discusses the use of an herb that can very effectively change the gender of the fetus. One of the expectant mothers in the clip states that she is seeing a physician because it is her first child, and, therefore, more risk is involved. She adds that if there is trouble while she is in labor, the doctor can perform a caesarian section, while a midwife would not have that capability. The American expectant mother discusses the testing her physician is able to perform and does not mention the use of a midwife.

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HANDOUTS

Handout 2-1: Fertility Problems and Solutions

Fertility Problems and Solutions

FEMALES

PROBLEM	SOLUTION
Damaged fallopian tubes	Surgery, in vitro fertilization
Abnormal ovulation	Hormone therapy, antibiotics, in vitro fertilization
Pelvic inflammatory disease (PID)	Antibiotics, surgery, change in birth control methods
Endometriosis	Antibiotics, hormone therapy, surgery, artificial insemination
Damaged ovaries	Surgery, antibiotics, hormone therapy
Hostile cervical mucus	Antibiotics, artificial insemination, hormone therapy
Fibroid tumor	Surgery, antibiotics
Stress	Relaxation techniques
Tipped uterus, fibroid tumors	Surgery

MALES

PROBLEM	SOLUTION
Low sperm count	Antibiotics, hormone therapy, artificial insemination, lowered testicular temperature
Dilated veins around testicle	Surgery, lowered testicular temperature, antibiotics
Damaged sperm ducts	Surgery, antibiotics
Hormone deficiency	Hormone therapy
Sperm antibodies	Antibiotics, in vitro fertilization
Chronic illness, alcoholism, drug abuse, long-term use of marijuana	Artificial insemination
Pollutants	Artificial insemination
Stress	Relaxation techniques

Adapted from Jewelewicz, R. (1989). Sexual and reproductive health. In Tapley, D. F., Morris, T. Q., Rowland, L. P., Weiss, R. J., Subak-Sharpe, G. J., & Goetz, D. M. (Eds.). *The Columbia University College of Physicians and Surgeons complete home medical guide* (Rev. Ed.). New York: Crow.

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Handout 2-2: Facts about Conception and Pregnancy (Answers)

Facts about Conception and Pregnancy

This handout can be used as an assignment to be completed before your lectures on conception and pregnancy or as a review. The answers are as follows:

Conception
1. ovary → fallopian tube → uterus → uterine wall (fertilized) or vagina (unfertilized)
2. penis → vagina → uterus → fallopian tube → egg (ovum)
3. Possible answers include blocked/damaged fallopian tubes, abnormal ovulation, pelvic inflammatory disease (PID), endometriosis, damaged ovaries, hostile cervical mucus, fibroid tumor
4. Possible answers include low sperm count, dilated veins around testicle, damaged sperm ducts, hormone deficiency, sperm antibodies
5. Possible answers include surgery, in vitro fertilization, hormone therapy, antibiotics, artificial insemination

Pregnancy
1. Possible answers include cessation of menses, breast tenderness, nausea
2. Stage 1: Germinal lasts two weeks (from conception until Week 2); the cells divide and attach to the uterine wall; the baby is called a "zygote"
   Stage 2: Embryonic stage lasts 6 weeks (from Week 2 until Week 8); the cell layers (endoderm, ectoderm, mesoderm) form; the baby is called an "embryo"
   Stage 3: Fetal stage lasts 7 months (from Week 8 until birth); all the child's systems are developing rapidly; the child is called a "fetus"
3. Possible answers are see an obstetrician/midwife; eat a healthy diet including calcium and multivitamin and mineral supplements; abstain from caffeine, alcohol, nicotine, and unnecessary drugs; get plenty of rest; avoid X-rays; exercise moderately
4. amniocentesis — fetal cells are taken via a needle from amniotic fluid
   chorionic villus sampling (CVS) — samples of hairlike material taken from embryo
   ultrasound sonography — high frequency sound waves produce an image of baby
5. Possible answers include alcohol, nicotine, X-rays, prescription and illicit drugs, illnesses of the mother such as rubella, influenza, and AIDS

Adapted from Strong, B. (1994). Instructor's resource manual for human sexuality. New York: McGraw-Hill. Chapter 13.

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Handout 2-2: Facts about Conception and Pregnancy (Questions)

Facts about Conception and Pregnancy

Review your knowledge of conception and pregnancy by answering the questions below.

Conception

1. Trace the journey of the egg in a woman's body (a. unfertilized; b. fertilized):

a. ovary → _____ → _____ → _____

b. ovary → _____ → _____ → _____

2. Trace the journey of sperm cells from ejaculation to conception:

penis_____ → _____ → _____ → _____ → _____

3. List three possible reasons for infertility in women.

a. _____

b. _____

c. _____

4. List two possible reasons for infertility in men.

a. _____

b. _____

5. List and define three treatments for infertility.

a. _____

b. _____

c. _____

Pregnancy

1. List three early signs and symptoms of pregnancy.

a. _____

b. _____

c._____

2. Name the three stages of prenatal development. How long does each stage last? What systems have developed? What is the developing child called?

Stage 1: _____ Stage 2: _____ Stage 3: _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

3. List six important components of good prenatal care.

1. _____
2. _____
3. _____

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4. _____
5. _____
6. _____

4. Name and describe three prenatal tests.
1. _____
2. _____
3. _____

5. Name six teratogens.
1. _____ 4. _____
2. _____ 5. _____
3. _____ 6. _____

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