Chapter 2
THE START OF LIFE: PRENATAL DEVELOPMENT

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LEARNING OBJECTIVES

LO 2.1: Describe how genes and chromosomes provide our basic genetic endowment.

LO 2.2: Compare monozygotic twins with dizygotic twins.

LO 2.3: Describe how the sex of a child is determined.

LO 2.4: Explain the mechanisms by which genes transmit information.

LO 2.5: Describe the field of behavioral genetics.

LO 2.6: Describe the major inherited disorders

LO 2.7: Describe the role of genetic counselors and differentiate between different forms of prenatal testing.

LO 2.8: Explain how the environment and genetics work together to determine human characteristics.

LO 2.9: Summarize how researchers study the interaction of genetic and environmental factors in development.

LO 2.10: Explain how genetics and the environment jointly influence physical traits, intelligence, and personality.

LO 2.11: Explain the role genetics and the environment play in the development of psychological disorders.

LO 2.12: Describe ways in which genes influence the environment.

LO 2.13: Explain the process of fertilization.

LO 2.14: Summarize the three stages of prenatal development.

LO 2.15: Describe some of the physical and ethical challenges that relate to pregnancy.

LO 2.16: What are the threats to the fetal environment, and what can be done about them?

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CHAPTER OUTLINE

II. Prologue: Going with the Odds
A. The Chen story illustrates the difficult decisions that sometimes accompany prenatal development.

III. Earliest Development
Learning Objectives 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7
Lecture Launchers 2.1, 2.2, 2.3, 2.4, 2.5
Student Activities 2.2, 2.3
MyDevelopmentLab Video: Genetic Counseling

A. Genes and Chromosomes: The Code of Life
1. Humans begin life as a single cell.
2. Our genetic code is stored and communicated in our **GENES**, *the basic units of genetic information*.
a) Genes are composed of sequences of **DNA (deoxyribonucleic acid)**, *the substance that determines the nature of every cell in the body and how it will function*.
b) Humans have over 25,000 genes.
c) Genes are arranged in specific locations and in a specific order along 46 **CHROMOSOMES**, *rod-shaped portions of DNA that are organized in 23 pairs*.
(1) One pair of chromosomes (via the gametes) is provided by the mother; one by the father at fertilization.
d) **GAMETES** (sperm and ova) are formed by a process called *meiosis*.
e) **ZYGOTE** *is one cell formed by fusion of the two gametes*.
f) All other cells replicate the genetic code by a process called *mitosis*.
g) There are tens of trillions of possible genetic combinations.

B. Multiple Births: Two—or More—for the Genetic Price of One
1. Less than 3 percent of all pregnancies produce twins; the odds are slimmer for three or more children.
2. **MONOZYGOTIC TWINS**, *who are genetically identical*, form when a cluster of cells in the ovum splits off within the first two weeks following fertilization.
3. **DIZYGOTIC TWINS**, who are produced when two separate ova are fertilized by two separate sperm, are no more genetically similar than two siblings.
4. Other kinds of multiple births (triplets, quadruplets, etc.) can form from either mechanism.
5. Using fertility drugs increases the chances of having a multiple birth.
a) 1 in 10 are dizygotic.
b) Older women are more likely to have multiple births.
c) Racial and ethnic differences affect the rate of multiple births.
d) Caucasian: 1 out of 86 dizygotic.
e) African American: 1 out of 70 dizygotic.

C. Boy or Girl? Establishing the Sex of the Child
1. The 23rd chromosome determines the sex of the child.
a) Females are XX.
b) Males are XY.
c) The father's sperm determines the sex of the child.

D. The Basics of Genetics: The Mixing and Matching of Traits
1. An Austrian monk, Gregor Mendel (mid-1800s), working with peas, discovered that when two competing traits were present, only one could be expressed.
a) *The trait that is expressed when two competing traits are present is called the* **DOMINANT TRAIT**.

b) *The trait that is present in the organism but not expressed is called the* **RECESSIVE TRAIT**.
c) **GENOTYPE** *is the underlying combination of genetic material present (but not outwardly visible) in an organism*.
d) **PHENOTYPE** *is an observable trait, the trait that is actually seen*.
e) Alleles are genes for traits that may take alternate forms.
(1) **HOMOZYGOUS** *is inheriting from parents similar genes for a given trait*.
(2) **HETEROZYGOUS** *is inheriting from parents different forms of a gene for a given trait.*
f) If a child receives a *recessive* allele from each parent, it will display the recessive characteristic.

2. Transmission of Genetic Information
a) Discussion of the transmission of phenylketonuria (PKU), an inherited disorder in which a child is unable to make use of an essential amino acid present in proteins found in milk and other foods. Untreated, PKU levels will build up, causing brain damage and mental retardation.

3. Polygenic Traits
a) Most traits are the result of **POLYGENIC INHERITANCE**, *in which a combination of multiple gene pairs is responsible for the production of a particular trait*.
b) Some genes (such as those for blood type AB) are neither dominant nor recessive but are a combination.
c) Some recessive genes are **X-LINKED GENES**, *meaning they are located on the X chromosome*.
(1) Males have a higher risk for a variety of X-linked disorders because they lack a second X chromosome to counteract the genetic information that produces the disorder.
(2) *Hemophilia* is a blood disorder produced by X-linked genes.

E. The Human Genome and Behavioral Genetics: Cracking the Genetic Code
1. In 2001, molecular biologists succeeded in mapping the human genome—the specific sequence of genes on each chromosome.
a) The number of human genes has been revised downward from 100,000 to 25,000.
b) Humans share 99.9 percent of the gene sequence.

2. *The most recent approach to the study of the effects of heredity on behavior and development is called* **BEHAVIORAL GENETICS**.
a) This field merges psychology—the study of behavior—with genetics—the study of transmission of characteristics through heredity.
b) These researchers are learning how behavioral difficulties (such as schizophrenia) may have a genetic basis.
c) Researchers also seek to identify how genetic defects may be remedied.

F. Inherited and Genetic Disorders: When Development Deviates from the Norm
1. Some genetic disorders are inherited (e.g., PKU).
2. Some genetic disorders are the result of genes that become physically damaged.
a) Sometimes genes spontaneously change their form, a process called *spontaneous mutation.*
b) Certain environmental factors, such as exposure to X-rays, can produce malformed genetic material.
c) Some genetic disorders include:
(1) **DOWN SYNDROME** *is a disorder produced by the presence of an extra chromosome on the 21st chromosome pair, once referred to as mongolism.*
(2) **SICKLE-CELL ANEMIA** *is a blood disorder that gets its name from the shape of the red blood cells in those who have it.*

(3) **FRAGILE X SYNDROME** *is a disorder produced by injury to a gene on the X chromosome, producing mild to moderate mental retardation.*
(4) **TAY-SACHS DISEASE** *is an untreatable disorder that produces blindness and muscle degeneration prior to death.*
(5) One male out of every 400 is born with **KLINEFELTER'S SYNDROME**, *a disorder resulting from the presence of an extra X chromosome that produces underdeveloped genitals, extreme height, and enlarged breasts.*

G. Genetic Counseling: Predicting the Future from the Genes of the Present
1. Discipline focuses on helping people deal with issues related to inherited disorders.
2. Genetic counselors use a variety of data.
a) They can take a thorough family history, seeking any familial incidence of birth defects.
b) The age of mother and father will be taken into account.
c) Blood, skin, and urine may be used to isolate and examine specific chromosomes.
d) Possible genetic defects can be identified by assembling a *karyotype*, a chart containing enlarged photos of each of the chromosomes.
3. Prenatal Testing: Other tests take place once the woman is already pregnant:
a) **ULTRASOUND SONOGRAPHY** *is a process in which high-frequency sound waves scan the mother's womb to produce an image of the unborn baby, whose size and shape can then be assessed.*
b) **CHORIONIC VILLUS SAMPLING (CVS)** *is a test used to find genetic defects that involves taking samples of hairlike material that surrounds the embryo.*
c) **AMNIOCENTESIS** *is the process of identifying genetic defects by examining a small sample of fetal cells drawn by a needle inserted into the amniotic fluid surrounding the unborn fetus.*
4. Screening for future problems
a) *Huntington's disease* and more than a thousand other disorders can be predicted based on genetic testing.
b) At home, genetic tests are joining the ranks of at-home pregnancy tests, whereby people simply collect a saliva specimen and send it off to a lab to uncover his or her carrier status for inherited conditions.
5. Are **DESIGNER BABIES** in our future?
a) Other advances include *germ-line gene therapy*, a process where genetic modifications can correct problems not only for unborn individuals but for future generations.
b) Technology is making possible the feat of *cloning*—the creation of a complete human being.

IV. The Interaction of Heredity and Environment
Learning Objective 2.8, 2.9, 2.10, 2.11, 2.12
Lecture Launcher 2.1, 2.5
Student Activity 2.1
MyDevelopmentLabVideo: Genetic Mechanisms and Behavioral Genetics

A. The Role of the Environment in Determining the Expression of Genes: From Genotypes to Phenotypes
1. An individual's **TEMPERAMENT**, *the patterns of arousal and emotionality that represent consistent and enduring characteristics,* may represent **MULTIFACTORIAL TRANSMISSION**, *traits that are determined by a combination of both genetic and environmental factors in which a genotype provides a range within which a phenotype may be expressed.*
2. Some genotypes are not as sensitive to the environment as others are.

B. Studying Development: How Much Is Nature? How Much Is Nurture?

1. The correct question is not whether behavior is caused by nature or nurture, but *how much* by nature and *how much* by nurture.
2. Nonhuman studies
    a) Scientists put laboratory animals bred to share genetic backgrounds in different environments to explore the effects of these environments.
    b) Conversely, they use genetically different animals in similar environments to determine the role of genetics.
3. Contrasting Relatedness and Behavior: Adoption, Twins, and Family
    a) Scientists use human twins to study the effects of genes and the environment.
    b) Differences between monozygotic twins separated at birth are most likely but not always due to different environments.
    c) If monozygotic twins are more similar than dizygotic twins on a particular trait, then we can assume that genetics plays a role.
    d) People who are unrelated but share the same environment also tell us about environmental influences.
    e) Researchers also study biological parents and their children versus adoptive parents and their children to see the effects of heredity versus environment.
    f) Bottom line: Virtually all traits, characteristics, and behaviors are the joint result of the combination and interaction of nature and nurture.
    g) The more genetically similar two people are, the more likely they are to share physical characteristics (e.g., height, weight).
    h) Genetics plays a significant role in intelligence; however, the environment is also a significant factor.

C. Genetics and the Environment: Working Together
1. Physical traits: Family resemblances—Twins plainly show a great deal of resemblance, but genetics also influences similarity of blood pressure, respiration, or longevity.
2. Intelligence: More Research, More Controversies—The extent to which "biology is destiny," especially with regard to cognitive skills, remains hotly contested.
3. Genetic and Environmental Influences on Personality: Born To Be Outgoing?
    a) Increasing evidence supports the conclusion that at least some personality traits have at least some genetic components.
    b) *Neuroticism* refers to the degree of moodiness, touchiness, or sensitivity an individual characteristically displays.
    c) *Extroversion* is the degree to which a person seeks to be with others, to behave in an outgoing manner, and generally to be sociable.
    d) Certain traits reflect the contribution of genetics more than others.
        (1) Social potency
        (2) Traditionalism
    e) Political attitudes, religious interests and values, even attitudes toward human sexuality seem to have genetic components.

D. Psychological Disorders: The Role of Genetics and Environment
1. Several psychological disorders have been shown to be related, at least in part, to genetic factors:
    a) Schizophrenia
    b) Major depression
    c) Alcoholism
    d) Autism
    e) Attention-deficit hyperactivity disorder

E. **Developmental Diversity**: Might a Culture's Philosophical Outlook Be Determined by Genetics?
1. Kagan and colleagues speculate that the underlying temperament of a given society, determined by genetics, may predispose people in that society toward a particular philosophy.

F. Can Genes Influence the Environment?
   1. Sandra Scarr (1993, 1998) suggests three ways a child's genetic predisposition might influence his or her environment:
      a) Children focus on environments that are connected with their genetically determined abilities.
         (1) Ex. Active, aggressive child toward sports
      b) Passive gene-environment influence
         (1) Ex. Sports-oriented parent, who has good coordination genes, provides many opportunities for a child to play sports.
      c) Genetically-driven temperament may evoke certain environmental influences.
         (1) Infant's demanding behavior causes parents to be more attentive.

V. Prenatal Growth and Change
Learning Objectives 2.13, 2.14, 2.15, 2.16
Lecture Launchers 2.2, 2.3, 2.4
Student Activities 2.3
MyDevelopmentLabVideo: Period of the Zygote

A. Fertilization: The Moment of Conception
   1. **FERTILIZATION** *is the process by which a sperm and an ovum—the male and female gametes—join to form a single new cell.*

B. The Stages of the Prenatal Period: The Onset of Development
   1. The prenatal period consists of three phases:
      a) The **GERMINAL STAGE** *is the first and shortest stage of prenatal development, which takes place during the first two weeks following conception.*
         (1) It is characterized by methodical cell division and the attachment of the organism (*blastocyst*) to the wall of the uterus.
         (2) The developing child is called a *zygote* at this stage.
         (3) The cells become specialized with some forming a protective layer around the zygote, while others create:
            (a) **PLACENTA**, *the conduit between the mother and fetus, providing nourishment and oxygen via the umbilical cord.*
      b) The second stage is called the **EMBRYONIC STAGE**, the period from two to eight weeks following fertilization during which significant growth occurs in the major organs and body systems.
         (1) At this point, the developing child is called an *embryo*.
         (2) The developing child is now composed of three layers:
            (a) The *ectoderm* is the outer layer forming the skin, hair, teeth, sense organs, brain, and spinal cord.
            (b) The *endoderm* is the inner layer producing the digestive system, liver, pancreas, and respiratory system.
            (c) The *mesoderm* is sandwiched between the inner and outer layers and forms the muscles, bones, blood, and circulatory system.
      c) The **FETAL STAGE** *begins about eight weeks after conception and continues until birth.*
         (1) *The developing child from eight weeks after conception until birth is called a* **FETUS**.
         (2) The fetus dramatically increases in size and weight.
         (3) Organs become more differentiated and operational.
         (4) By three months, the fetus swallows and urinates.
         (5) By four months, the mother will be able to feel her fetus move.

C. Pregnancy Problems:
   1. **INFERTILITY:** Fifteen percent of couples suffer from **INFERTILITY**, *the inability to conceive after 12 to 18 months of trying to become pregnant.*
      a) Infertility is produced by several causes:
         (1) The age of the parents
         (2) Previous use of birth control pills, illicit drugs or cigarettes, STDs
         (3) Men who have an abnormally low sperm count
         (4) The woman's *mother* taking certain drugs during pregnancy
         (5) The most common cause of infertility is failure to release an egg through ovulation—possibly caused by hormonal imbalance, damage to fallopian tube or uterus, or stress.
      b) There are several approaches to conception.
         (1) **ARTIFICIAL INSEMINATION** is a process of fertilization in which a man's sperm is placed directly into a woman's vagina by a physician.
         (2) **GAMETE INTRAFALLOPIAN TRANSFER (GIFT)** and **ZYGOTE INTRAFALLOPIAN TRANSFER (ZIFT)**, procedures in which an egg and sperm or fertilized egg are implanted in a woman's fallopian tubes.
         (3) **IN VITRO FERTILIZATION (IVF)** is a procedure in which a woman's ova are removed from her ovaries, and a man's sperm are used to fertilize the ova in a laboratory.
            (a) IVF Statistics
               (i) Success rates as high as 33% for younger women (lower rates for older women)
               (ii) Worldwide, more than 3 million babies created via IVF
            (b) Examples of IVF
               (i) Choosing sex of baby
               (ii) In rarer cases, a **SURROGATE MOTHER**, a woman who agrees to carry the child to term, may be used in cases where the mother is unable to conceive; she is artificially inseminated by the biological father, and she gives up rights to the infant.
   2. Ethical Issues
      a) Ethical and legal issues, as well as emotional concerns, are present and may result in the rights of the mother, the father, the surrogate mother, and ultimately the child being in conflict.
      b) Sex selection techniques are even more troubling, and questions arise about intervening in the reproductive process to obtain a favored sex or other characteristics.
      c) Evidence suggests that the quality of parenting in families who have used artificial means to conception may even be superior to naturally conceived children.
      d) The psychological adjustment of children conceived artificially is no different than that of children conceived using natural techniques.
   3. Miscarriage and Abortion
      a) A *miscarriage*—known as spontaneous abortion—occurs when pregnancy ends before the developing child is able to survive outside the womb.
         (1) 15 to 20% of all pregnancies end in miscarriage.
         (2) Many times, the mother is not even aware she is pregnant.
         (3) Typically, miscarriages are attributable to some sort of genetic abnormality.
         (4) *Abortion* is the voluntary termination of a pregnancy by the mother.
D. The Prenatal Environment: Threats to Prenatal Development
   1. Certain aspects of mother's and father's behavior, both before and after conception, can produce lifelong consequences for the child.

a) Some of the most profound consequences are brought about by a **TERATOGEN**, *an environmental agent such as a virus, chemical, or other factor that produces a birth defect*.
b) At some phases of prenatal development, a teratogen may have minimal impact; at other periods, consequences can be severe.

2. Mother's Diet: A mother's diet clearly plays an important role in bolstering the development of the fetus.
   a) A woman who eats a varied diet high in nutrients is apt to have fewer complications during pregnancy, an easier labor, and a generally healthier baby.
3. Mother's Age: Research shows that mothers over 30 and adolescent mothers are at greater risk for a variety of pregnancy and birth complications:
   a) Premature birth
   b) Low birth weight
   c) Down syndrome
   d) Higher infant mortality rates for adolescent mothers
4. Mother's Prenatal Support
   a) Many teenage moms do not have enough economic and social support.
      (1) May affect infant health
      (2) Prevents getting good prenatal care
5. Mother's Health: Illness in a pregnant woman can have devastating consequences.
   a) *Rubella* (German measles) prior to the 11th week can cause blindness, deafness, heart defects, or brain damage.
   b) *Chicken pox* and *mumps* may cause birth defects and miscarriage, respectively.
   c) *Syphilis* and *gonorrhea* can be transmitted to the child.
   d) *AIDS* (acquired immune deficiency syndrome) can affect newborns
      (1) If a mother with AIDS takes antiviral drugs (e.g. AZT), less than 5% of infants are born with the disease.
      (2) Babies born with AIDS must remain on antiviral drugs their entire lives.
   e) Mental health: maternal depression can affect a child's development.
6. Mother's Drug Use: Mother's use of legal and illegal drugs pose serious risks to the unborn child:
   a) Aspirin, for example, taken for a headache, can lead to fetal bleeding.
   b) *Thalidomide* causes missing limbs.
   c) *DES (diethylstilbestrol)* later caused cervical and vaginal cancer in daughters.
   d) *Marijuana* restricts oxygen to the fetus.
   e) *Cocaine* restricts blood flow and oxygen; babies are born addicted and go through withdrawal; they are shorter and weigh less; they have serious respiratory problems and birth defects or seizures; it is often impossible to soothe them.
7. Mother's Use of Alcohol and Tobacco: Both alcohol and cigarettes can disrupt the development of the fetus:
   a) **FETAL ALCOHOL SYNDROME (FAS)** *is a disorder caused by the pregnant mother consuming substantial quantities of alcohol during pregnancy, potentially resulting in mental retardation, delayed growth, and facial deformities.*
      (1) Even smaller amounts of alcohol can produce **FETAL ALCOHOL EFFECTS (FAE)**, *a condition in which children display some, although not all, of the problems of FAS due to their mother's consumption of alcohol during pregnancy*.
      (2) Just two drinks a day have been associated with lower intelligence.
   b) Smoking reduces the oxygen content and increases carbon monoxide.
      (1) Babies can miscarry or are born with abnormally low birth weight.
      (2) Babies born to smokers are shorter and may be 50% more likely to have mental retardation.

8. Fathers can affect the prenatal environment:
    a) Secondhand smoke can affect the mother's health.
    b) Alcohol and illegal drugs can lead to chromosomal damage at conception.
9. Stress may produce an unhealthy environment for the mother.
10. Sperm damage may result from father's exposure to environmental toxins in the workplace.

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LECTURE LAUNCHERS

Lecture Launcher 2.1: The Epidemic That Wasn't—Crack Babies

The findings of Barry Lester's longitudinal research on crack babies are discussed in this *New York Times* article. Although there are significant differences in IQ between those exposed to crack prenatally and their non-exposed counterparts, the differences are smaller than even Lester expected and likely not clinically significant. Students can be divided into groups to do their own research on a particular teratogen and then they can report out.

Okie, S. (2009). The epidemic that wasn't. *The New York Times*.
http://www.nytimes.com/2009/01/27/health/27coca.html?pagewanted=all&_r=0

Lecture Launcher 2.2: Fertility

Traditionally, estimates of women's fertility ranged anywhere from two days to ten days a month. However, a study by the National Institute of Environmental Health Sciences in Research Park, NC, published in the *New England Journal of Medicine*, found that women are fertile for five days before ovulation as well as on the day of ovulation. Researchers were surprised to find that having sex just one day after ovulation will not result in a pregnancy. Kits are available which tell when a woman is ovulating. (For couples wanting to avoid pregnancy, these researchers suggest abstaining from sex, or using birth control, during this six-day period.)

According to the study, the probability of conception ranges from 10% when intercourse occurs five days before ovulation to 33% when it happens on the day of ovulation. Daily intercourse results in the highest chance of pregnancy, 37%. The study had some other findings: There is no evidence that the timing of intercourse influences whether the baby will be a boy or a girl. Also, there is no sign that aging sperm is more likely to produce babies with defects, although the study was too small to support this conclusively.

On average, couples have a 20% chance of getting a viable pregnancy each month. However, according to Dr. Allen Wilcox, who conducted the study, "even couples who are very fertile are not fertile in every cycle. We don't understand why that is." Results from another study show that women who drink three or more cups of coffee a day reduce their chances of conception by 26 percent. It is believed that caffeine disrupts the menstrual cycle and may lead to early pregnancy loss.

Wilcox, A. J., Weinberg, C. R., & Baird, D. D. (December 7, 1995). Timing of sexual intercourse in relation to ovulation. Effects on the probability of conception, survival of the pregnancy, and sex of the baby. *New England Journal of Medicine*, 333(23), 1517–1521.

Wilcox, A. J., Baird, D. D., Dunson, D. B., McConnaughey, D. R., Kesner, J. S., & Weinberg, C. R. (2004). On the frequency of intercourse around ovulation: Evidence for biological influences. *Human Reproduction*, 19(7), 1539–1543.

Wilcox, A. J. (2010). *Fertility and pregnancy: An epidemiologic perspective*. Oxford University Press.

Lecture Launcher 2.3: Infertility

Contrary to popular opinion, infertility rates are not on the rise. In 1965, the U.S. 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:

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.

The top five procedures for fertilization include:

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

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:

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

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

Ferin, M., Jewelewicz, R., & Warren, M. (1993). *The menstrual cycle: Physiology, reproductive disorders, and infertility*. New York: Oxford University Press.

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.

Lecture Launcher 2.4: In Vitro Fertilization and Multiple Births

In 2009, a single mother named Nayda Suleman gained national attention when she gave birth to octuplets. Dubbed the "Octomom" by the press, Suleman already had six children, with all of her pregnancies being the result of *in vitro* fertilization, which can carry the consequence of multiple births. Several popular reality television programs, such as *Kate Plus 8*, have also made celebrities out of parents

who have had multiple birth pregnancies using assisted reproduction technologies. All of this attention has caused some people to ask whether children from multiple birth pregnancies are at risk for developmental problems.

Concern over developmental problems with multiple births focuses on two distinct issues. First, multiple birth pregnancies are associated with premature births, lower birth weights, and other complications from having multiple fetuses in the womb at once. Because abnormal *in utero* development can have a long lasting impact on brain development, multiple birth pregnancies have the potential to cause permanent cognitive disabilities.

The other issue of concern regarding the development of children in multiple birth families is whether the strain that so many children at the same age puts on a family interferes with the parents' abilities to provide a healthy environment. For example, parents may have little time and attention to devote to each child. Furthermore, the financial burdens may cause children to go without toys and other items.

Introduce the concept of multiple births to students, along with their increased prevalence when in vitro fertilization is used. Ask students to discuss whether they believe children from large, multiple birth pregnancies are likely to have their development affected in a negative way. Should fertility doctors be banned from implanting more than one or two embryos at a time? Do they feel that children in large families from single births are also at risk? To extend the activity, ask students to respond to the writing prompt below.

Lecture Launcher 2.5: My Mother, Myself

Many people feel that their mothers are "a part of them." Recent findings suggest that there may be considerable truth to that phrase.

Many adults apparently still have cells in their bodies that they picked up from their mothers during the gestation period. Similarly, many mothers still have cells in their bodies that came from their own children during pregnancy. Technically speaking, these "guest cells" are actually the product of stem cells that got planted in the "host's" body and started reproducing decades later. And, technically speaking, there aren't too many of them. Some estimates put the number of foreign cells at less than one in a million, a comforting thought for anyone conjuring up images of parasitic offspring or alien-like entities living happily rent-free.

The meaning of these *microchimeras* is less clear. There is some evidence that these cells might contribute to autoimmune diseases, although there is also speculation that these cells might confer a health benefit. Because this area of study is relatively young, there remain more questions than answers (such as, what about women who have cells from both their mothers and their own offspring?). It's comforting to know, though, that in some small way a parent is always with us.

Ritter, M. (2003, May 9). Moms, you've got a little of your kids inside you. *Austin American-Statesman*, A1, A16.

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STUDENT ACTIVITIES

Student Activity 2.1: The Nature-Nurture Issue: Lessons from the Pillsbury Doughboy

David B. Miller uses a cooking metaphor to describe the intricate interactions between genetics/biology (nature) and the environment/learning (nurture). In his metaphor, flour represents genes. He takes four different food items, which represent four different developmental outcomes that all use flour as a base but that have other ingredients that interact with the flour in unique ways.

1. FLOUR + SALT + WATER + FRIED IN SHORTENING = FLOUR TORTILLA
2. FLOUR + SALT + WATER + BAKED WITHOUT SHORTENING = MATZO
3. FLOUR + SALT + WATER + YEAST + BAKING = BREAD
4. FLOUR + SALT + BUTTER + COCOA + SUGAR + BAKING = BROWNIE

Depending on how adventuresome you feel, you can demonstrate this lesson in a variety of ways. You can bring in an example of each ingredient (e.g., a bag of flour, a box of salt, some water, a can of shortening, a packet of yeast, some butter, a can of cocoa, a bag of sugar, and perhaps a toy oven) and use them as props to create the "developed" results (e.g., tortilla, matzo, bread, and brownie). You could actually mix some of the ingredients and assign students to go home and finish them. Finally, you could assign small groups ahead of time to make the various products and bring them to class; each group must explain how their ingredients relate to real-world human development (i.e., flour = genes, salt = culture, water = health, baking/frying = home environment). Each group must explain their results. Miller suggests that the metaphor of tortilla versus matzo shows how similar ingredients (i.e., shared genes of identical twins) can yield different developmental outcomes (i.e., different personalities, intelligence, etc.) due to different environments (i.e., baking versus frying).

Miller, D. B. (1996). The nature-nurture issue: Lessons from the Pillsbury Doughboy. In Ware, M. E. and Johnson, D. E. (Eds.), *Handbook of demonstrations and activities in the teaching of psychology, Volume II: Physiological-comparative, perception, learning, cognitive, and developmental*. Mahwah, NJ: Lawrence Erlbaum Associates. pp. 201–203.

Student Activity 2.2: Conception and Pregnancy

Use **Handout 2-2** for this assignment. Distribute the handout before you discuss conception and pregnancy. Tell students that some of the answers are in Chapter 2 and some they will have to find on their own using other sources.

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:

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 stage lasts two weeks (from conception till 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 drugs such as Thalidomide, illicit drugs such as cocaine and marijuana, illnesses of the mother such as rubella, influenza, and AIDS

Student Activity 2.3: Buying Eggs or Finding a Sperm Donor or Surrogate on the Internet

Ask students to use the Internet to explore their options for becoming parents. Have them note the prices paid for eggs, sperm, etc., by visiting several sites that offer reproductive help or reproductive services.

Pose the following question: How far is too far to go? Ask students what they would do if they wanted to have a child, but could not. (Consider the following possibilities: they found out that they are infertile; they have a genetic condition that has a chance of being passed to their offspring.) You might also share **Handouts 2-3 and 2-4** in this context. Handout 2-3 lists some dominant and recessive characteristics that sometimes influence people's wishes for a "designer baby." Handout 2-4 lists some common teratogens that can affect prenatal development.

Student Activity 2.4: Reflective Journal

Ask students to interview a woman about her pregnancy; ideally, a family member, but any close friend, colleague, or willing acquaintance will do. Distribute **Handout 2-5** as a starting point for their task, and emphasize that the interviewee's responses should form the basis for the student's own reflections.

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SUPPLEMENTAL READING

American Baby, Parenting, Parent and Child, Family Fun, Kiwi, Working Mother

These magazines, although designed for a lay audience, can often be a source of lecture topics, current events, or even information to be clarified from a scientific perspective. Consider subscribing to one or more of these titles if you teach this class on a regular basis.

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.

Murkoff, H. E., & Mazel, S. (2008). *What to expect when you're expecting* (4th ed.). New York: Workman.

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

Nilsson, L., Ingelman-Sundberg, A., & Wirsen, C. (2004). *A child is born* (4th ed.). New York: Delta Press.

Lennart Nilsson is justly famous for his amazing photographs of babies *in utero*, first published in 1965. Share these with your class. The film *The Miracle of Life* also uses some of his microphotography.

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MULTIMEDIA IDEAS

MyDevelopmentLab Video Series + Discussion Questions

The **MyDevelopmentLab Video Series** engages students and brings to life a wide range of topics spanning prenatal development through the end of the lifespan. New international videos shot on location allow students to observe similarities and differences in human development across various cultures.

Video: Genetic Counseling

Discussion Questions

1. What are your thoughts on genetic counseling after viewing this clip? Did viewing this video change your opinion on the topic?
2. Would you, or did you, seek genetic counseling during your pregnancy? Why or why not? Would you recommend it to others?
3. The professional interviewed lists several reasons why individuals might consider genetic counseling. List and describe at least three.

Video: Period of the Zygote

Discussion Questions

1. Explain the steps involved in the process of fertilization.
2. What is the correct sequence of stages that take place during the zygotic period, and what is the timeframe for each?
3. Sketch the location of the female reproductive organs, noting key areas involved in zygotic development.

Video: Genetic Mechanisms and Behavioral Genetics

Discussion Questions

1. Review the process of genetic transmission, focusing on how parental chromosomes contribute to the formation of a new life.
2. Explain how family studies, adoption studies, and twin studies provide key information to researchers studying behavioral genetics.
3. Comment on the specific findings of the studies described by the researcher interviewed in the video. Which outcomes did you find most interesting, unusual, or unexpected?

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Handout 2-1

Fertility Problems and Solutions

WOMEN

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

MEN

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.

Handout 2-2

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:

__ovary_____ → _____ → _____ _____ fertilized _____ unfertilized

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. _____

Handout 2-2, continued

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.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

4. Name and describe three prenatal tests.

   a. _____

   b. _____

   c. _____

5. Name six teratogens.

a. _____	b. _____
c. _____	d. _____
e. _____	f. _____

Handout 2-3

Dominant and Recessive Characteristics

Characteristics in the left-hand column dominate over characteristics listed in the right-hand column.

	DOMINANT TRAITS	RECESSIVE TRAITS
eye coloring	brown eyes	grey, green, hazel, blue eyes
vision	farsightedness	normal vision
	normal vision	nearsightedness
	normal vision	night blindness
	normal vision	color blindness*
hair	dark hair	blonde, light, red hair
	nonred hair	red hair
	curly hair	straight hair
	full head of hair	baldness*
	widow's peak	normal hairline
facial features	dimples	no dimples
	unattached earlobes	attached earlobes
	freckles	no freckles
	broad lips	thin lips
appendages	normal number	extra digits
	normal digits	fused digits
	normal digits	short digits
	normal joints	fingers lack 1 joint
	normal proportion	limb dwarfing
	normal thumb	clubbed thumb
	normal joints	double-jointedness
other	immunity to poison ivy	susceptibility to poison ivy
	normal pigmented skin	albinism
	normal blood clotting	hemophilia*
	normal hearing	congenital deafness
	normal hearing and speaking	deaf mutism
	normal—no PKU	phenylketonuria (PKU)

**sex-linked characteristic*

Handout 2-4

Possible Teratogens

This list of suspected teratogens contains many common items. Most babies are born without defects, so the placenta may be an effective barrier. Additionally, the timing of the exposure to a teratogen is critical to its impact on prenatal development. Overall, more damage is likely early in the pregnancy when organ systems are developing.

DISEASES

Chlamydia	Pneumonia	Gonorrhea
Rubella (German Measles)	Herpes	Scarlet Fever
HIV	Syphilis	Mumps
Toxoplasmosis	Tuberculosis	Influenza

DRUGS

Accutane	Hexachlorophene	Alcohol
Iodides	Amphetamines	Lithium
Antibiotics	LSD	Anti-cancer drugs
Opiates	Anticoagulant drugs	Quinine
Aspirin	Sedatives	Barbiturates
Smallpox vaccination	Caffeine	Thalidomide
Nicotine	Tranquilizers	Cocaine
Vitamins in excess	Diethylstilbestrol (DES)	Marijuana

ENVIRONMENTAL FACTORS

Cadmium	Mercury	Cat feces
Nickel	Fumes from paints, solvents, glues, dry-cleaning fluids	Pesticides
Insecticides		Herbicides
Manganese	Radiation (X-rays, video display terminals)	
Hair dyes	Polychlorinated Biphenyls (PCBs)	Lead

NONINFECTIOUS MATERNAL CONDITIONS

Alcoholism	Chemical dependency	Phenylketonuria
Rh + factor	Anemia	Stress
Diabetes Mellitus	Young/older mother	

Handout 2-5

Journal Exercise 2

If possible, interview your parents or guardians (if this is not possible, try an aunt, or uncle, or grandparent) about your own prenatal development. Use the following questions to get started.

1. Was this a planned pregnancy?
2. Was this your first baby?
3. How did you find out you were pregnant?
4. How did you feel?
5. Were you working?
6. When did you see a doctor?
7. Did you take vitamins?
8. When did you start feeling the baby?
9. When did you begin wearing maternity clothes?
10. What changes did your body go through?
11. What are some of the strongest memories you have of this pregnancy?
12. Did you have any prenatal tests?
13. How did your lifestyle change?
14. Did you smoke? Drink alcohol? Drink coffee or tea? Take any drugs?
15. Did you know the sex of the baby before the birth? Did you have a preference for a boy or a girl? How did you feel when you found out the sex of your baby?
16. When did you decide on a name for the baby?
17. Did you attend any special classes or workshops about childbirth, nursing, etc.?
18. Did you know of any preexisting conditions?
19. Where were you living?
20. Were there any features or characteristics you were hoping the baby would have? Were there any you were hoping the baby would NOT have?
21. How much of your partner's medical history did you know? In retrospect, how important would that have been?
22. What roles or expectations did you have for this child?
23. What influenced your decision to have a child at this time?
24. Did you have any trouble conceiving? Did you expect to have any trouble becoming pregnant?

Reflect on what you learned. How do you think your own pregnancy (or your partner's) will be (or was) the same or different than your mother's?

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