CHAPTER 2
Heredity and Conception

CHAPTER LEARNING OBJECTIVES

1. Explain the difference between a gene and a chromosome, and explain how a baby's sex is determined.
2. Describe the processes of mitosis and meiosis and how twins are formed.
3. Describe the process of genetic transmission, how traits are passed from parents to children.
4. Discuss the causes and characteristics associated with chromosomal and genetic abnormalities.
5. Explain the techniques for prenatal testing for various genetic disorders.
6. Describe how studies of adopted children and identical (monozygotic) versus fraternal (dizygotic) twins are used to explore the relative influences of nature versus nurture. Include in this discussion a description of genotype and phenotype and between reaction range and canalization.
7. Explain the formation of egg and sperm and where conception takes place.
8. Discuss causes of infertility and methods couples can use to conceive.

CHAPTER OVERVIEW

This chapter provides an overview of the biological processes of heredity and conception, including all of the basic structures (e.g., chromosomes, genes, DNA) and processes (e.g., mitosis, meiosis, fertilization, and implantation) involved in the formation of a new human being. The relation between genotype and phenotype in developmental outcome is described, and the potential disorders resulting from various chromosomal and genetic abnormalities discussed. Research strategies for examining the contribution of genes and environment to development are introduced. The chapter concludes with a discussion of infertility and alternative pregnancy methods, including ways in which LGBT couples can become parents. Interesting features include a discussion of the gender imbalance in diverse countries and parental attempts to select the gender of their child.

CHAPTER OUTLINE

I. The Influence of Heredity on Development: The Nature of Nature

A. Chromosomes and Genes

1. Heredity is based on the biological transmission of traits from one generation to the next and defines ones nature; genetics is the field within the science of biology that studies heredity.
2. Normal human cells have 23 pairs (46 total) of **chromosomes**, containing **genes** that are composed of **deoxyribonucleic acid (DNA)** and that determine traits. Most traits of interest to psychologists are **polygenic**.

B. Mitosis and Meiosis

1. During **mitosis**, all 23 pairs of chromosomes are exactly replicated (barring random mutations), resulting in cell division and growth or tissue replacement.
2. **Meiosis** is reductive division, which leads to the production of sperm or ova containing 23 chromosomes, half of the DNA found in normal cells.
3. **Mutations** of cells can occur through environmental influences.
4. 22 chromosomes in sperm and eggs are **autosomes** and the 23rd is a **sex chromosome**; mothers contribute an X and fathers contribute either an X (to create a female) or a Y (to create a male).

C. Identical and Fraternal Twins

1. **Monozygotic twins (MZ)** are derived from a single zygote that has split in two, resulting in two children that are genetically identical.
2. **Dizygotic twins (DZ)** are derived from two zygotes, meaning they share about 50% of genetic material, the same as other siblings.
3. DZ twins run in families, and the chances of twins increase with maternal age and the use of fertility drugs.

D. Dominant and Recessive Traits

1. Traits are determined by **alleles**, which are one member of a gene pair. Having matching alleles for a trait is known as being **homozygous** and non-matching alleles as **heterozygous.**
2. Gregor Mendel discovered simple patterns of inheritance: co-dominance, in which the effects of both alleles are expressed, and the law of dominance, in which the dominant allele will be expressed as in the case of eye and hair color, masking the expression of the recessive allele. Most traits are more complex.
3. Many genes determine **dominant traits** or **recessive traits.**
4. A person having a recessive gene for a disease may not see the effects of the disease because the dominant copy of the gene cancels out the recessive effects, but they are known as **carriers**.

II. Chromosomal and Genetic Abnormalities

A. Chromosomal Abnormalities

1. Children who do not inherit the normal number (46) of chromosomes experience health and behavioral problems. The risk for chromosomal abnormalities increases with parental age.
2. **Down syndrome** occurs when a child has an extra copy of the 21st chromosome and results in characteristic facial features, as well as cognitive and physical deficiencies.
3. Most people with **sex-linked chromosomal abnormalities** are infertile.
   a. XYY males have heightened male secondary characteristics.
   b. XXY males (**Klinefelter syndrome)** usually have enlarged breasts and are mildly mentally retarded. They are often treated with testosterone replacement therapy.

c. OX females (**Turner syndrome)** are typically short, do not develop breasts or menstruate, produce little **estrogen,** and have a specific pattern of cognitive deficits.

d. XXX females (Triple X syndrome) are normal in appearance but typically have deficits in language skills and memory for recent events.

B. Genetic Abnormalities

1. Children with **phenylketonuria (PKU)** have two copies of the recessive gene causing the disorder and cannot metabolize a specific amino acid, thus cannot include it in their diets or there will be serious consequences (i.e., mental retardation).
2. **Huntington disease** is a rare neurodegenerative disease transmitted via a dominant gene.
3. **Sickle-cell anemia** is caused by a recessive gene and results in the altered shape of red blood cells, decreasing the oxygen supply. This can lead to both cognitive and physical problems.
4. **Tay-Sachs** disease is also caused by a recessive gene and causes degeneration of the central nervous system, and ultimately death.
5. **Cystic fibrosis**, caused by a recessive gene, results in excessive mucus production and increased risk of respiratory infections.
6. **Hemophilia** and Duchenne **muscular dystrophy** are caused by recessive genes on the X chromosome, and are thus known as **sex-linked genetic abnormalities.** Because females have two copies of the X chromosome, they are less likely to show these disorders.

C. Genetic Counseling and Prenatal Testing

1. Genetic counselors address the probability of having children with genetic abnormalities based on the parent's genetic make-up and family medical histories.
2. **Amniocentesis**, examining fetal cells isolated from amniotic fluid, can detect the presence of over 100 chromosomal and genetic abnormalities, such as **spina bifida,** in the developing fetus, but carries a small risk of miscarriage.
3. **Chorionic Villus Sampling (CVS)** can diagnosis abnormalities earlier in pregnancy than amniocentesis but has a slightly greater risk of miscarriage. In this procedure, a syringe is inserted in the **uterus** to sample the villi.
4. An **ultrasound** creates a "picture" (**sonogram)** of fetus by using information about the reflection of sounds waves. It is beneficial in determining position of fetus, as well as the fetal age and sex.
5. A maternal blood tests, **alpha-fetoprotein (AFP) assay,** is used to detect a variety of disorders in the fetus.

III. Heredity and the Environment: Nature versus Nurture

A. Reaction Range

1. **Reaction range** describes the possible variation in the expression of an inherited trait and is influenced by the environment.
2. **Genotype** refers to the alleles that are inherited, while **phenotype** refers to the actual traits expressed from these alleles.

B. Canalization

1. Some aspects of development, such as infant motor development, and strongly influenced by **canalization,** whereas the environment plays stronger roles in the development of personality and intelligence.

C. Genetic-Environmental Correlation

1. Scarr proposed three types of genotype-environment correlations: **passive genetic-environmental correlation** (child passively receives both genes and environment from parents), **evocative genetic-environmental correlation** (child's characteristics evoke a

certain response from others), and **active genetic-environmental correlation** (child's characteristics influence the child's selection of environments, known as **niche-picking)**.

2. The interaction of genes and environment in development is termed **epigenesis.**

D. Kinship Studies: Are the Traits of Relatives Related?

1. People who share more genetic material (i.e., close relatives) should be more alike on qualities affected by genes than those who share less genetic material (i.e., non-relatives).

E. Twin Studies: Looking in the Genetic Mirror

1. The logic behind twin studies is that if MZ twins show greater similarity on a trait that DZ twins, that trait is influenced by genetics. This is the case for many traits, such as intelligence, personality traits, and psychological disorders such as **autism.**
2. A confound of twin studies is that twins raised together share not only genetics, but environment. Thus, researchers often compare MZ twins that were reared apart to account for this.

F. Adoption Studies

1. If children are more like their adoptive parents on a trait, it is likely strongly influenced by nurture. If children are more like their biological parents on a trait, it is likely strongly influenced by genetics.
2. A Closer Look – Observing Children, Understanding Ourselves - Twins: researchers gather data on twins at annual twin festivals. Watch the video on twins and answer questions regarding twins.

IV. Conception: Against All Odds

A. Ova

1. **Conception** occurs when the chromosomes from a sperm cell and an ovum combine to form one cell with 23 chromosome pairs.
2. All the ova a woman will ever have are present in an immature form at birth and begin to mature during puberty.
3. There is a monthly release of a mature egg (which is much larger than a sperm) into the **fallopian tube**, where the egg is propelled by cilia.
4. If the ovum in not fertilized, it is discharged along with **endometrium** in the menstrual flow.
5. A Closer Look--Diversity: Where Are the Missing Chinese Girls?
   a. China's one-child policy and cultural preference for male children have resulted in a skewed gender balance of children.
   b. In the past, many girls were abandoned by their parents and subsequently adopted by foreigners. China has greatly tightened its restrictions on adoptions and claims there are not enough available babies. This may be to protect the image of the country.
   c. It is also possible that sex-selective abortion is replacing female infanticide as China's predominant method of sex-selection.

B. Sperm Cells

1. Half the sperm a man's body makes will carry a Y chromosome and swim more quickly than the other half, which contain an X chromosome.
2. Although 200 to 400 million in ejaculate, only 1 in 1,000 will arrive in the vicinity of ovum. Sperm cells are apparently attracted to the ova by the odor of a chemical secreted by the egg.
3. Sperm secrete an enzyme to allow penetration of the gelatinous layer that surrounds the ovum. Once *one* sperm enters, this layer thickens, locking out all other sperm.
4. More male fetuses suffer from **spontaneous abortion** than females.

V. Infertility and Assisted Reproductive Technology

A. Causes of Infertility

1. A couple is considered infertile if they cannot conceive after trying for one year. and 1 in 6 or 7 American couples will experience fertility problems. The man is the source of the problem in about 40% of the cases.

B. Causes of Fertility Problems

1. Causes among men include low sperm count, deformed sperm, low sperm motility, infectious diseases, and direct trauma to testes. These can be caused by genetic factors, environmental poisons, diabetes, STIs, overheating testes, pressure to testes, aging, and the effects of drugs. Many of the conditions affect sperm motility**.**
2. Fertility problems among women include failure to ovulate, infections such as **pelvic inflammatory disorder (PID),** and **endometriosis** which results in blocked fallopian tubes.

C. Helping People with Fertility Problems become Parents

1. Methods for LGBT to become parents include home insemination, intrauterine insemination, in vitro fertilization, and reciprocal in-vitro insemination for female partners and use of a surrogate for male partners.
2. Depending on the cause of infertility, various methods may be used to achieve pregnancy, including **artificial insemination, in vitro fertilization, donor IVF,** and **embryonic transplant.**
3. Those desiring children may also obtain children from **surrogate mothers** or adoption. Today, greater numbers of adopted children are older, have spent some time in foster care, are of other races, have special needs, and were born in other countries

D. A Closer Look--Real Life: Selecting the Sex of Your Child: Fantasy or Reality?

1. Many folklores and old wives tales suggest ways to conceive a child of a certain gender, but preimplantation genetic diagnosis (PGD) is a fool-proof way to select the sex of a child. In this method, the sex of an embryo is determined in vitro, and only the ones that are the desired sex are implanted into a mother's uterus. There are moral and ethical questions associated with this method.

ANSWER KEY: *TRUTH OR FICTION?*

1. Your father determined whether you are female or male.
   TRUE. If we receive another X sex chromosome from our fathers, we develop into females. If we receive a Y sex chromosome (named after its Y shape) from our fathers, we develop into males.
2. Brown eyes are dominant over blue eyes.
   TRUE. If one parent carries genes for only brown eyes, and the other for only blue eyes, the children would have brown eyes. But brown-eyed parents can also carry recessive genes for blue eyes.
3. You can carry the genes for a deadly illness and not become sick yourself.
   TRUE. This occurs when genes are recessive and dominant genes cancel their effects.
4. Girls are born with all the egg cells they will ever have.
   TRUE. At birth, women have around 400,000 ova, but they are in immature form.
5. About 120 to 150 boys are conceived for every 100 girls.
   TRUE. Sperm with Y sex chromosomes appear to swim faster than sperm with X sex chromosomes. This is one of the reasons why between 120 and 150 boys are conceived for every 100 girls.

6. Sperm travel about at random inside the woman's reproductive tract, so that reaching the ovum is a matter of luck.
   FALSE. Although the journey of sperm is literally blind, it is apparently not random. Sperm cells are apparently attracted by the odor of a chemical secreted by ova.
7. Extensive athletic activity may contribute to infertility in the male.
   TRUE. Overheating of the testes, which happens now and then among athletes, such as long-distance runners, and pressure, which can be caused by certain bicycle seats, are two causes of male infertility.
8. "Test-tube" babies are grown in a laboratory dish throughout their nine-month gestation period.
   FALSE. "Test-tube" babies are conceived in a laboratory dish or vessel and then injected into the uterus, where they must become implanted to develop successfully.
9. You can select the sex of your child.
   TRUE. Preimplantation Genetic Diagnosis (PGD) is a fool-proof sex-selection method, but it is medically invasive and expensive, and successful implantation cannot be guaranteed.

IDEAS FOR INSTRUCTION

I. The Influence of Heredity on Development: The Nature of Nature

A. Key Terms

heredity
genetics
chromosomes
genes
polygenic
deoxyribonucleic acid (DNA)
mitosis
mutation
meiosis
zygote
autosome
sex chromosome
monozygotic (MZ) twins
dizygotic (DZ) twins
ovulation
allele
homozygous
heterozygous
dominant traits
recessive traits
carrier
multifactorial problems

B. Lecture Expanders

What Kind of Twin: Monozygotic or Dizygotic?

Students often assume that if twins look alike, they are identical (monozygotic) twins. Although DNA testing is the only method that can determine the zygosity of twins with 100% accuracy, several questionnaires have also been developed that are highly accurate and less costly than DNA testing. Present one of these to your class (for instance, Price et. al (2000) has published a parental questionnaire that is 95% accurate. The questionnaire includes information about the similarity of twins' hair color, texture, the timing of teething, etc.). However, these surveys are only effective after the twins have been born. If an ultrasound reveals that twins are sharing an amniotic sac and a placenta in utero, they must be identical. Yet separate amniotic sacs do not always indicate fraternal twins, although twin fetuses of different sexes always indicate fraternal twins.

Price, T.S., Freeman, B., Craig, I., Petrill, S. A., Ebersole, L. & Plomin, R. (2000). Infant zygosi ty can be assigned by parental report. *Twin Research, 3*,129-133.

Minnesota Twin Studies: What Do We Know?

Consider using this website as a springboard for classroom discussions regarding methodology in studying twins, what is known about monozygotic and dizygotic twins, and what type of research is continuing. Conduct an in-class discussion on what traits are primarily due to genetics and what are primarily due to environment. https://mctfr.psych.umn.edu/

C. Classroom Activities and Demonstrations

Video Suggestions

Cracking the Code of Life (2001, NOVA, 120 minutes). This video chronicles the race to capture the complete letter-by-letter sequence of genetic information – the human genome. Eric Lander, director of the

Whitehead Institute/MIT Center for Genome Research presents a light-hearted look at genetic science. Also included is a segment about two brothers who both have children with Tay-Sachs disease. This video may also be viewed online through the interactive companion website: http://www.pbs.org/wgbh/nova/genome/

After Darwin: Genetics, Eugenics, and Human Genome (1999, Films for the Humanities and Social Sciences, 2 parts, 49 and 46 minutes). Extensive presentation of genetic science using historical footage and interviews and including information on the Human Genome Project and cloning, and a discussion of the discriminatory practices of insurance companies in paying for prenatal testing and infertility treatments.

II. Chromosomal and Genetic Abnormalities

A. Key Terms

Down syndrome
sex-linked chromosomal abnormalities
Klinefelter syndrome
Turner syndrome
estrogen
phenylketonuria (PKU)
Huntington's disease
sickle-cell anemia
Tay-Sachs disease
cystic fibrosis
hemophilia
sex-linked genetic abnormalities
muscular dystrophy
genetic counseling
prenatal
amniocentesis
spina bifida
chorionic villus sampling
uterus
ultrasound
sonogram
alpha-fetoprotein (AFP) assay

B. Lecture Expanders

Say "Cheese": Prenatal Pictures

Although ultrasounds were developed for medical purposes, many companies now offer pregnant women 3-D and 4-D ultrasounds in order to see their babies before they are born. 3-D ultrasounds almost look like photographs (there are several examples on the Web). 4-D (four-dimensional) ultrasounds add the element of time to 3-D ultrasound images, so that women can purchase a video of their unborn child moving around. Thus, these ultrasounds do not provide any medical information about the health or gestational age of the baby; they just provide pretty pictures that cost a pretty penny! Many companies offering this service, including Prenatal Peek and Fetal Fotos, operate informative and slickly marketed websites. You can debate the pros and cons of this with your class.

C. Classroom Activities and Demonstrations

Video Suggestions

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

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

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

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

D. Student Projects

Genetic Counseling

Have students contact a genetic counselor and interview that person regarding his/her role in helping parents who are expecting a child or considering conceiving a child. Students can generate a list of questions regarding career choice (how did this person become a genetic counselor) and what the counselor enjoys and doesn't enjoy about the job. Has this person seen an increase in any particular type of genetic disorder? Etc., etc.

If possible, have the counselor visit class or participate via Skype.

Prior to contacting a genetic counselor, have students find information online regarding this profession. One possible site is the National Society of Genetic Counselors: http://www.nsgc.org/

Early Prenatal Risk Assessment: http://www.nsgc.org/

In small groups, have students explore this website devoted to the early detection of prenatal conditions. Have them view the videos and information written for both mothers and professionals. How useful do they think this information would be if they were an expectant mother (or father) or a professional? Ask students to find other similar websites and compare and contrast each of them in terms of validity of the information provided and the usefulness for expectant parents.

Prenatal Assessment – Video

Ask students to visit WebTutor or the premium website (register/purchase access at www.cengage.com/login) to view the video "Prenatal Assessment." This video is featured in Chapter 2. Below are the video narration and the application questions with answers on Prenatal Assessment.

Video Narration: During a routine prenatal visit, ultrasound is used to estimate fetal age, determine the position and growth of the baby, and determine the health of the placenta. The ultrasound uses sound waves to produce an image of the unborn child for analysis. In high-risk pregnancies, the ultrasound is used to check for fetal abnormalities. Women approaching or beyond the age of 35 have a higher risk of having a baby with Down syndrome and other chromosomal abnormalities. Here, Dr. Cohen performs a detailed ultrasound to help rule out birth defects. While the ultrasound cannot diagnose chromosomal or other abnormalities, it is a useful screen for estimating risk and the need for additional diagnostic tests such as amniocentesis.

Application Questions and Answers:

1. According to Dr. Cohen, what is the most common chromosomal abnormality seen in live-born babies?
   - *Down syndrome*

   What is the prevalence of this disorder?
   - *According to Dr. Cohen, 1/270 pregnancies in women over the age of 35*

   What is the relationship between maternal age and the risk of having a baby with this disorder?
   - *Positive correlation between maternal age and Down syndrome*

2. Dr. Cohen explains how multiple prenatal assessment measures can be used together to make decisions regarding whether further medical monitoring procedures, such as amniocentesis, are necessary. Does he recommend an amniocentesis for Eleanor? Why or why not?
   - *Does not recommend an amniocentesis*
   - *States that there is more than a 99% chance that she will not have a baby with a chromosomal abnormality based on her age alone*
   - *Discusses 1/200 risk of losing the pregnancy due to amniocentesis*
   - *States that if the ultrasound is normal, the risk of losing the baby due to complications resulting from the amniocentesis is twice as high as Eleanor's risk of having a baby with Down syndrome*

3. Describe the ultrasound procedure as performed by Dr. Cohen. What is the position of the baby?

- *Breach presentation, Dr. Cohen states that 95% of the time the baby will turn around by the time the pregnancy is full term*

What structures does Dr. Cohen identify?

- *Examines the placenta and describes it as the organ that feeds the baby nutrients and oxygen*
- *Points out head and skull*
- *Shows brain, paying close attention to the cerebellum*
- *Moves down length of spine*
- *Shows beating heart*
- *Examines femur, thigh bone, and discusses the importance of measuring limb length*

What important health information is learned as a result of this ultrasound test?

- *Ultrasound results are normal, ruling out the need for additional diagnostic tests*

4. Describe two structural abnormalities and/or markers of chromosomal abnormalities discussed by Dr. Cohen as he performs the ultrasound.
   - *Cerebellum, if normal, chance that baby has spina bifida is very small*
   - *Femur, measurements of limb length are important, short femur length is associated with Down syndrome*

5. What risks are associated with various prenatal assessment measures?
   - *Maternal blood analysis, AFP screening: high risk of false positive result*
   - *Amniocentesis: risk of losing the pregnancy to miscarriage*
   - *Chorionic villus sampling: some concern about fetal limb abnormalities, increased risk of miscarriage*

How are decisions made regarding which measures to use?

- *Maternal age*
- *Stage of pregnancy*
- *Abnormal ultrasound findings*
- *Previous child with a genetic or other disorder*
- *Family history of genetic or other disorder*
- *Ethnic origin*
- *Multiple miscarriages*

What are some ethical considerations in the use of prenatal monitoring procedures?

- *Selective abortion controversies, i.e., sex, disability status*
- *False negative/positive results and decision making*
- *Risk of miscarriage and infection*

How prevalent are birth defects resulting from genetic factors?

- *Prevalence rates vary depending on type of genetic abnormality and other factors, i.e., chromosomal, autosomal, and X-linked disorders*

How can the family histories of prospective parents be used to determine the likelihood of a baby having a genetic disorder?

- *Some genetic disorders are heritable, such as autosomal recessive disorders, while others, such as mutations, are not*
- *Family history is used to assess risk of heritable genetic disorders*

6. What are some other, non-genetic factors that can affect prenatal development?
   - *Maternal disease, e.g., rubella, toxoplasmosis, sexually transmitted diseases*
   - *Drugs*
   - *Alcohol*
   - *Cigarette smoke*
   - *Environmental hazards, e.g., radiation, pollutants*
   - *Other maternal characteristics such as diet, depression, stress, age*

Are there certain time periods in pregnancy when the developing baby is more vulnerable than others? Why?

- *The most serious structural defects occur during period of the embryo, from 3rd through 8th week of pregnancy, when all basic organs and limbs are being formed*

7. Eleanor began taking prenatal vitamins three months prior to conception, and she stopped consuming alcohol in the month prior to conception. What problems will her careful, planned approach likely rule out?
   - *Fetal alcohol syndrome, spina bifida (folic acid)*

What other behaviors may affect the health of a child prior to, or very early in, pregnancy?

- *Exercise*
- *Diet*
- *Drug use*
- *Smoking*

III. Heredity and the Environment: Nature versus Nurture

A. Key Terms

reaction range
genotype
phenotype
canalization
passive genetic – environmental correlation
evocative genetic – environmental correlation
active genetic – environmental correlation
epigenesis
autism

B. Lecture Expanders

Genotype-Environment Effects

The textbook briefly points out that expressed traits represent an interaction of heredity and environment. However, Sandra Scarr and Kathleen McCartney's (1983) widely cited theory of genotype-environmental effects during development explains these interactions in much greater detail. These authors propose three genotype-environmental interactions: passive, evocative, and active. (These interactions also tie in nicely with the active-passive controversy presented in Chapter 1). Each of these interactions influences the expression of phenotypes in developing children.

In the passive genotype-environment effect, biological parents provide both their child's DNA and their environment. For example, parents who are talented musicians may pass down genes that allow a child to develop perfect pitch and an environment with high levels of exposure to music. Thus, the child may express musical talent. This influence is most influential early in development when a child's environment is most influenced by his or her parents.

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

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

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

C. Classroom Activities and Demonstrations

Illustrating a Reaction Range

Gottman's conceptualization of heredity-environment interactions is called range of reaction. The notion is that genetics sets upper and lower limits on environmental influences (e.g., nutrition, learning, accidents, illness, environmental toxins, schooling, and social class). One way to help your students grasp this concept is to have them generate examples of how multiple phenotypes are possible from one genotype in the areas of physical, cognitive, and social development. First have them propose traits that they think are very heavily influenced by heredity and traits they think have very little genetic influence. Next, have them think about what genetics might direct in the phenotype (e.g., two tall parents pass on genes for tall height to their children) and then have them place that genotype in a variety of environments (e.g., poor nutrition, adequate nutrition, excellent nutrition) and describe the multiple outcomes. You might even have students generate graphs of their examples as a way to highlight the way heredity and environment are said to interact in this model.

Video Suggestions

Fathers and Autism. (2008, ABC Video: Childhood and Adolescent Development, 2:08 minutes). A look at how the father's age affects the chance of a child being born with autism.

D. Student Projects

What's My Risk? http://learn.genetics.utah.edu/content/begin/traits/activities/

Have students consider their parents, siblings, grandparents, great grandparents, aunts/uncles, and cousins in terms of physical characteristics, behavioral characteristics, and psychological characteristics. What overlap do they see between themselves and these individuals and among these individuals?

One interesting way to gather and understand this information is provided on the University of Utah website, http://learn.genetics.utah.edu/content/begin/traits/activities/. Have students try out several of these activities and report back to the class on their findings. Of particular interest to young adults might be the "What's Your Family Health Story?" activity in which students interview their family to determine what type of health issues might run in their family. Discuss which of these health issues are preventable and/or treatable?

IV. Conception: Against All Odds

A. Key Terms

conception	endometrium
fallopian tube	spontaneous abortion

B. Lecture Expanders

Microsort®: Sex-Selection by Sperm Sorting

One new technology used for sex-selection not discussed in the text is Microsort® (Genetics & IVF Institute, 2009). This method, currently used in clinical trials, sorts sperm before conception to increase the proportion of either sperm containing either an X or Y chromosome, depending on the desired sex. The sperm is then used via intrauterine insemination or in vitro fertilization. Thus, the chances of having a girl or boy are also increased. The sorting is based on differences in the amount of DNA: sperm cells with an X chromosome contain approximately 2.8% more total DNA than sperm cells having a Y chromosome. This DNA difference can be measured and the X- and Y-bearing sperm cells individually separated using a modified flow cytometer instrument. However, this technology does not result in the complete exclusion of either X- or Y-bearing sperm from the final sperm preparation, meaning that this method is not 100% accurate like Preimplantation Genetic Diagnosis (PGD). According to the information on the website, MicroSort is effective in the number of babies born of the desired gender from this technology that raises the percentages to 93% for girls and 82% for boys. Currently, to use this technology, couples must be married and seeking to avoid transmitting a sex-linked genetic disorder or seeking gender balance in their

family. Furthermore, using this technology is quite expensive. This technology is the center of an ethical debate that you can discuss with your students.

Microsort®. Retrieved September 1, 2012 from http://www.microsort.net/index.php

C. Classroom Activities and Demonstrations

Folk Wisdom

Perhaps no other period of life generates as much fascination and misinformation as the gestation and delivery of a new baby. Folk wisdom, or old wives' tales, concerning pregnancy and birth are still passed on today. Some are based on fact and observation; others are derived from fears or a cultural belief. Ask students to share some folk wisdom they have heard about determining the sex of the fetus. While relatives are a good source, you can also make this a cross-cultural study and suggest that students do some research into the folk wisdom or specific cultures in regards to determining the sex of the fetus before this class discussion. Discuss how the folk wisdom presented relates (or does not relate) to the science of conception.

D. Student Projects

Determining Ovulation

When couples are trying to conceive, they may use many methods to determine when the woman is ovulating in order to appropriately time sexual intercourse to her most fertile time. Have students write a report presenting at least three methods that can be used to determine ovulation and a discussion of the pros and cons of each method. There are many web resources that will be helpful to students in completing this project, including the American Pregnancy Association and FertilityFriend.com. You may expect students to include charting basal body temperature, the presence and consistency of cervical mucus, and ovulation prediction kits that indicate the presence of luteinizing hormone.

V. Infertility and Assisted Reproductive Technology

A. Key Terms

motility	endometriosis	donor IVF
pelvic inflammatory disease	artificial insemination	embryonic transplant
	in vitro fertilization	surrogate mother

B. Lecture Expanders

Octomom and IVF

Some fertility treatments increase the risk of having multiples. For instance, the once popular TV show *Jon & Kate plus 8* and *Kate plus 8* showcases a family that has twin daughters and sextuplets. In January 2009, Nadya Suleman, dubbed the "Octomom," gave birth to octuplets after having six embryos implanted during an *in vitro fertilization* procedure. However, higher order multiple pregnancy is undesirable because of the many risks to both the mother and the fetuses. Many countries have laws that restrict the number of embyos that can be transferred. Currently, the US has no laws governing embryo transfer, but the American Society for Reproductive Medicine has published a set of guidelines. It actually recommends that women under the age of 35 with a favorable prognosis should only have a single embyo transferred.

American Society for Reproductive Medicine (2008). Guidelines on number of embyos transferred. *Fertility and Sterility, 90 (S3),* S163-S164. Retrieved from http://www.asrm.org/uploadedFiles/ASRM_Content/News_and_Publications/Practice_Guidelines/Guidelines_and_Minimum_Standards/Guidelines_on_number_of_embryos(1).pdf

C. Classroom Activities and Demonstrations

You Be the Infertility Counselor

In conjunction with its hour-long video *Test Tube Babies,* PBS offers a fun interactive Web activity called "You Be the Counselor." This activity presents the case files of several couples trying to conceive, and

then asks what sort of fertility treatment you would recommend. Feedback is given on your selection. This activity can be done as a class, in small groups, or individually. You can access this activity at http://www.pbs.org/wgbh/amex/babies/sfeature/clinic.html.

Video Suggestions

Making Babies (1999, PBS, 60 minutes). Frontline program on reproductive medicine and the questions regarding safety, commercialization, and the changing face of the family. This video has an interactive companion website, http://www.pbs.org/wgbh/pages/frontline/shows/fertility, and includes online videos on high-tech procedures, information on human cloning, and a short quiz.

18 Ways to Make a Baby (2001, NOVA, 60 minutes). Louise Brown, born in 1978, was the first baby conceived outside the womb and since that time, reproductive science has moved forward in ways you may not have thought about. At least 18 ways are discussed, including the baby with five parents, and a report on Arceli Keh, who gave birth at 63 after she lied about her age to participate in an egg donation program. An interactive website provides tutorials and other activities: http://www.pbs.org/wgbh/nova/baby/.

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

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

Male Menopause. (2008, ABC Video: Lifespan Human Development, 7:47 minutes). One doctor believes there is a key to longevity through a controversial diet, exercise, and hormone regimen that postpones "male menopause," or the onset of old age in men.

D. Student Projects

The Cost of Infertility

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

LGBT Family Building

Have students explore this website www.theafa.org (American Fertility Association) for information devoted to how LGBT individuals and couples can have a family. Have them evaluate those options in terms of fesibility, affordability and availability. If a gay couple chooses to use surrogacy as an option in choosing to have children, what legal considerations must they face that heterosexual couples do not?