HOW DO **GENES** AFFECT **ADDICTION?**

Experts in genetics are discovering how genes can affect a person's risk of becoming addicted to drugs or alcohol. Their studies could help prevent and treat this illness.

Why do some people become addicted to alcohol, tobacco, or other drugs while others do not? That's one important—and complex—question scientists are trying to answer.

Many different factors act together to affect a person's risk for addiction. **Environmental factors**—such as stress, peer pressure, and the strength of family relationships—play a role. The risk for becoming addicted is also strongly influenced by **biological factors**, including age and gender.

Scientists now know that another important biological factor is a person's **genes**—the units of hereditary material that are passed down from parent to child.

Researchers are studying the link between genes and addiction to learn how to better prevent and treat this potentially deadly illness.

Genes and Heredity

All of your traits, from your hair color to your eyesight, are influenced by your genes. These segments of DNA contain instructions for making the proteins that are used to build the body's cells. These proteins also direct all of the processes that occur inside your cells.

Genes in the human body can have different forms, called **variants**. The slight differences between these variants cause individuals to have distinct characteristics, such as blue eyes versus brown. You inherit genes from your parents, which is why family members typically share similar traits.

Scientists have now identified some genes that are linked to addiction. They have found certain gene variants that occur more often in people who are addicted to alcohol, tobacco, or other drugs.

This means that a person who has one of these gene variants is at a greater risk for developing an addiction than someone who doesn't. Because people inherit genes from their parents, individuals who have family members who struggle with addiction may be at a greater risk for addiction. However, genes alone are not a cause of addiction.

Risk Doesn't Equal Addiction

Most people with high-risk genes will not become addicted to alcohol or drugs. Likewise, a person without a genetic risk can still become addicted. Scientists estimate that genetics accounts for roughly half a person's likelihood of developing an addiction.

Other biological and environmental factors in a person's life that influence the likelihood of addiction include:

- **Risk factors**, such as having friends who use drugs and experimenting with drugs during adolescence when the brain is still developing. Risk factors can increase a person's chances.

- **Protective factors**, such as strong family relationships and getting involved in after-school clubs and hobbies. Protective factors can decrease a person's chances.

Individuals can help keep themselves safe by trying to increase protective factors and eliminate risk factors in their environment.

Age: An Important Risk Factor

One of the most important risk factors for addiction is the age at which a person starts to use alcohol, tobacco, or other drugs.

The brain, which continues to develop until a person's early to mid-twenties, is much more vulnerable to addictive substances while it is developing. Studies have shown that addiction is much more likely in people who start using substances in their adolescence.

One of the most important things you can do to decrease the risk of addiction is to protect your brain from addictive substances while it is still developing.

FUTURE TREATMENTS

By studying how genes affect addiction, scientists hope to improve how we prevent and treat the disorder. Much research aims to understand how a specific gene affects the way a person's brain responds to alcohol or drugs.
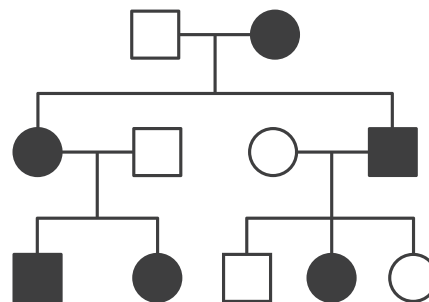
Researchers have discovered genes that affect how nicotine, the addictive drug found in cigarettes, changes the activity of the brain circuits that control functions such as attention, appetite, and habit formation. People who have high-risk variants of genes that control nicotine's effects are more likely to transition from occasional cigarette smoking to regular use and nicotine addiction.

This information is helping scientists develop better treatments for addiction. For instance, studies have shown that medications used to treat nicotine addiction were particularly helpful for people who had high-risk nicotine genes. In the future, scientists may even be able to develop medications that can reverse the effects of high-risk genes.

TRACKING GENES

A **pedigree** (example at right) is a diagram scientists use to study traits among family members. Scientists may use pedigrees to investigate the way certain traits, including diseases such as addiction, are influenced by genes.

Different symbols are used to represent each person, with lines showing family connections and colors showing a trait. If a trait occurs repeatedly through different generations, it can mean that genes are an influence.
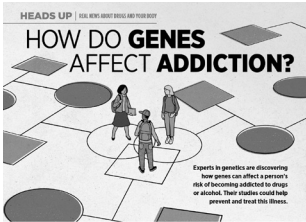
KEY:

☐ Male   Parents

◯ Female   Children
                  (in birth order)

● ■ Individuals Showing Trait

◯ ☐ Individuals Not Showing Trait

HEADS UP

REAL NEWS ABOUT DRUGS AND YOUR BODY

HEADS UP | REAL NEWS ABOUT DRUGS AND YOUR BODY

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How Do Genes Affect Addiction? NIH National Institute on Drug Abuse

One of the keys to preventing negative consequences of drug and alcohol use is determining what puts people at risk for addiction. In the article "How Do Genes Affect Addiction?," students will learn about the role of genetics in a person's risk for addiction, as well as learn that genetics isn't the only factor that influences the risk. Many other biological and environmental factors play a role, and students will get tips about choices they can make to reduce their risk. By sharing the article and skills sheet (see reverse side) with your students, and teaching the lesson below, you can help them understand the risks and how to stay safe.

Subject

- Science Literacy
- English Language Arts
- Health/Life Skills

Common Core State Standards

RST.6-8.1 / RST.9-10.1
- Cite specific textual evidence to support analysis of science and technical texts

W.6-8.1 / W.9-10.1
- Write arguments to support claims, using valid reasoning and relevant and sufficient evidence

Next Generation Science Standards

MS-LS3.A / HS-LS3.A
- Inheritance of Traits

MS-LS3.B / HS-LS3.B
- Variation of Traits

National Science Education Standards

- Reproduction and Heredity
- Personal Health

National Council for the Social Studies

- 4. Individual Development and Identity
- 8. Science, Technology, and Society

Tiered Vocabulary Tools:
- scholastic.com/headsup /teachers/how_do_genes _affect_addiction

Additional Teaching Resources:
- headsup.scholastic.com /teachers
- teens.drugabuse.gov

Critical-Thinking Questions

1) How might doctors use genetics to prevent or treat addiction in the future? *(Answers may include that genetics might determine if a person's genes put them at a higher risk for addiction. People who may have an increased risk because of genetics could be provided with counseling or other interventions. Doctors may one day be able to develop medications that can reverse the effects of high-risk genes.)*

2) Do you think scientists will find a single "addiction gene" that determines if someone will become addicted to drugs? Why or why not? *(Answers may include that it is unlikely that a single addiction gene exists. There are many factors that determine whether a person becomes addicted to drugs or not. Genes might affect how a person reacts to drugs, but they don't guarantee that a person will or will not develop an addiction.)*

3) Why is it important for people to understand the risk factors for addiction? *(Answers may include that knowing their risk can help people make healthy choices; people can take actions that reduce risk factors, such as not taking drugs during adolescence.)*

Writing Prompts

- **Grades 6–8:** Explain how genes could increase or decrease a person's risk for addiction.

- **Grades 9–10:** What are two reasons genetics research is important in understanding and treating addiction? Use evidence from the text to support your answer.

- **Grades 11–12:** Do you think individuals can control their risk for addiction? Why or why not?

Student Skills Sheet

The worksheet on the reverse side provides students with information about some of the different factors that can affect a person's risk for addiction and asks critical-thinking questions about the information. Possible answers include:

1. A protective factor is something that reduces the risk for addiction, such as strong family bonds or having friends who don't use drugs. A risk factor is something that increases a person's addiction risk, such as a family history of addiction or a lack of parental supervision. *(Examples are found in the table.)*

2. A person with no family history of addiction and strong family bonds can still be at risk for addiction. These two factors alone do not determine whether or not a person will develop an addiction. Many factors can come into play, and everyone reacts differently to situations.

3. A person can reduce his or her risk by increasing the number of protective factors in his or her life, such as spending time with people who are a positive influence and don't use drugs; not taking drugs at a young age; and getting involved in after-school activities such as music, sports, or school clubs.

Interactive Activity

- "PI: Pedigree Investigator, On the Case of Nicotine Addiction" (**learn.genetics .utah.edu/content/addiction/pi/**)

This activity gives more information about how pedigrees are constructed and has students complete one to see how nicotine addiction runs in a family.

- **Writing Prompt:** Does the family described in the activity support the theory that there is a genetic component to nicotine addiction? Use at least three pieces of evidence to support your answer. Explain how using a pedigree helped you determine your answer.

WHAT AFFECTS THE RISK FOR ADDICTION?

Scientists have identified many of the factors that can increase—and decrease—a person's risk for addiction.

Risk factors can increase the likelihood of becoming addicted to alcohol, tobacco, and/or other drugs. They include biological factors—such as a person's genetics and gender—and factors that come from the environment, including peer pressure or family relationships. **Protective factors** are biological or environmental factors that help to decrease a person's risk for addiction, such as strong community bonds and friends who are a positive influence.

In general, the more risk factors and the fewer protective factors a person has, the higher the chance for addiction. However, every individual is different. A person can still become addicted to drugs even if he or she has few risk factors. And most people who are at risk never become addicted to drugs. Study the table at the right to learn about some of the factors that affect the risk for addiction.

Directions: *Study the information in the table below. Then use it along with the information from the article "How Do Genes Affect Addiction?" to answer the questions below. Write your answers on separate paper.*

Risk and Protective Factors for Addiction

⚠️ RISK FACTORS	➕ PROTECTIVE FACTORS
• Family history of addiction	• Strong family bonds
• Lack of parental supervision	• Parental supervision and involvement
• Lack of strong family bonds	• Friends who are a positive influence and don't use drugs
• Friends or family who use alcohol, tobacco, or other drugs	• Strong neighborhood/community
• Availability of drugs	• Clear anti-drug use policies at home and in school
• Drug use during adolescence	• Strong performance in school
• Mental health problems such as depression	• Participation in after-school activities
• Stress	• Having strategies to cope with stress
• Exposure to trauma or violence	

QUESTIONS:

1. Explain the difference between a protective factor and a risk factor for addiction. Give at least one example of each.

2. Suppose a person has no family history of drug addiction and has strong bonds with his or her parents. Is it guaranteed that the person will not become addicted to drugs or alcohol themselves? Support your answer with evidence from the texts.

3. Suppose a person has uncontrollable risk factors for addiction, such as a genetic history of the disease. How can the person reduce his or her own risk? Explain at least two specific actions that can be taken.

VOCABULARY LIST
GRADES 6–12

Dear Teacher,

The vocabulary list on the following pages is drawn from the "Do Genes Cause Addiction?" student article and "Who Is at Risk?" work sheet.

This vocabulary can be previewed with students prior to reading or reinforced with students afterward. Encourage students to incorporate these words into their writing and discussion of both the article and the work sheet.

The vocabulary list integrates two different tiers of vocabulary words that would be used across several content areas, such as *distinct*, *manipulate*, and *susceptible*, and domain-specific words, such as *DNA*, *gene*, and *protein*.

Supplement for: "How Do Genes Affect Addiction?"

- Student Article: **scholastic.com /headsup/how_do_genes_affect _addiction**

- Teacher's Guide (includes work sheet): **scholastic.com/how_do_genes _affect_addiction**

Some suggestions for students to help their understanding:

- organize concept maps that include word parts, synonyms, antonyms, and examples;
- compose memory aids that explain the words or use them in a meaningful context;
- employ the words to create newspaper articles, stories, or poems.

Sources: Unless otherwise noted, definitions below are sourced or adapted from *Merriam-Webster's Collegiate dictionary* and *Scholastic Children's Dictionary*

activate *(verb)*: to make active or more active

addicted *(adjective)*: having a compulsive (uncontrollable) behavior, such as drug use, that continues despite negative consequences

addiction *(noun)*: a brain disorder or illness associated with compulsive (uncontrollable) behavior, such as drug use, despite negative consequences

addictive *(adjective)*: something, such as a drug, that causes changes to the brain that result in compulsive (uncontrollable) behavior despite negative consequences

adolescence *(noun)*: the period of life when a child develops into an adult

analyze *(verb)*: to study or examine something closely or carefully in order to understand it

bind *(verb)*: to attach to something

biological *(adjective)*: of or having to do with living things and their processes

cell *(noun)*: the smallest unit that makes up a living organism. Some organisms are made of only one cell, but others, like humans, are made of trillions of cells.

characteristic *(noun)*: a quality or trait that exists in a person, group, or thing

develop *(verb)*: to grow or cause something to become larger or more advanced

distinct *(adjective)*: different or separate

DNA *(noun)*: the molecule found in cells that carries instructions for cell structure and processes in the body. DNA contains genes that are passed on from parents to offspring and gives living things their inherited characteristics. The letters DNA stand for deoxyribonucleic acid.

environmental *(adjective)*: of or having to do with the objects and conditions in a set of surroundings

factor *(noun)*: something that helps to cause a result

gene *(noun)*: a small section of DNA that contains the instructions for making a protein or proteins that control the processes that occur in the body's cells.

genetic *(adjective)*: relating to, caused by, or controlled by genes

genetics *(noun)*: the genetic makeup of an organism, a group of organisms, or a condition. Also, the scientific study of the ways that personal characteristics are passed from one generation to another through genes.

hereditary *(adjective)*: passed on or able to be passed on from parent to offspring through genes

heredity *(noun)*: the process by which genes and traits are passed from parent to offspring

influence *(verb)*: to affect or change the properties or development of something

inherit *(verb)*: to receive from a parent through the transmission (passing on) of genes

interact *(verb)*: to act upon one another

likelihood *(noun)*: probability of occurring

makeup *(noun)*: the way in which the parts of something are put together

manipulate *(verb)*: to control, use, or change something in a skillful way

nicotine *(noun)*: the addictive chemical found in tobacco

pedigree *(noun)*: the history of a family's genes or traits. Pedigrees are represented in a chart and indicate how traits are passed on from parent to offspring.

potentially *(adverb)*: possible; being able to occur or develop

prevent *(verb)*: to stop from happening

protective *(adjective)*: providing a shield or cover from harm or damage

protein *(noun)*: a substance found in all living things that is made of amino acids, which are composed mainly of nitrogen, carbon, oxygen, and hydrogen. Proteins have specific functions and are involved in nearly all important cell processes.

reduce *(verb)*: to make smaller in size, amount, or number

risk *(noun)*: the possibility of loss or injury; danger

segment *(noun)*: one of the parts into which something is divided

slight *(adjective)*: small

strategy *(noun)*: a plan or method for reaching a certain goal

substance *(noun)*: a material with a specific chemical makeup

supervision *(noun)*: the action of watching over and directing something or someone

susceptible *(adjective):* open or particularly prone to something

trait *(noun)*: a quality or characteristic that makes one person different over another.

transition *(noun)*: a change from one state, stage, or place to another

variant *(noun)*: something that shows a difference from other things of the same type

vulnerability *(noun):* the state of being exposed or open to danger or harm