

Focus On This: The Biology of ADHD

Jessica Ogulnik
Niles West High School
Skokie, Illinois

Laura M. Stiles
Wakefield High School
Raleigh, North Carolina

In collaboration with Patricia Mersereau¹ and Sue Visser²

¹Battelle Centers for Public Health Research and Evaluation

²National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Focus On This: The Biology of ADHD

Jessica Ogulnik
Niles West High School
Skokie, Illinois

Laura M. Stiles
Wakefield High School
Raleigh, North Carolina

Summary

This lesson is for a standard level high school biology course and is meant to review and strengthen the concepts of neuron physiology and neurotransmission, and connect these concepts to attention-deficit/hyperactivity disorder (ADHD). In order to complete these activities students should have prior knowledge of nervous system terminology and function.

Learning Outcomes

- Students will be able to label and draw a neuron and all of the parts of a neuron—the axon, dendrite, axon terminal, cell body, myelin sheath, and nucleus.
- Students will be able to describe the cycle of neurotransmission—impulse, neurotransmitter release, and uptake.
- Students will research and debate the use of medication in ADHD treatment from an assigned point of view.
- Students will be able to list both pros and cons of including medication as part of ADHD treatment plans.

Materials

1. Computers with Internet access for the class or one computer with a projector and speakers.
2. A class set of pipe cleaners in 5 different colors. (Each student will need 5 pipe cleaners in 5 different colors. For five students, a teacher would need to provide 25 pipe cleaners, 5 of each color.)
3. Copies of handouts mentioned in Teacher Preparation section below.
4. 8½" x 11" white paper—2 sheets per student)
5. Yellow, black, green and blue sheets of construction paper—2 sheets of each per student
6. Scissors—1 pair per student
7. Biology textbooks to use as reference materials.

Total Duration

5 hours

Procedures

Note to teachers: ADHD is a subject that might be particularly sensitive for some students. Students might have ADHD or know a person with ADHD, so it is important that this subject be treated in a manner that is sensitive to students' needs.

Teacher Preparation

The teacher should prepare photocopies of handouts. Copies—one set per student—will need to be made of the “ADHD: The Treatment Debate” handout and rubric from the Conclusion step.

The class will need access to computers with an Internet connection in order to view demonstrations of neuron function and to conduct their research on ADHD. If Internet access in the classroom is not available for each student, the teacher shall arrange for a computer and projector to show the class the animation used in Step 3. If Internet access is not available, students can conduct research for the ADHD debate as homework, make a transparency of the neuron and synapse diagrams, or photocopy the images for each student. The materials should be organized for each group to model neurotransmission. Each group will need: 2 pieces of white paper, 8½" x 11"; 3 yellow circles, 2" in diameter; 12 black circles, ½" in diameter; 3 blue rectangles, 1" x 2"; and 3 green crescents (the crescent needs to fit the black circles).

Web Resources

Title: National Resource Center on AD/HD

URL: <http://www.help4adhd.org>

Description: This website provides information about ADHD, including causes, myths, frequently asked questions (FAQs), and "What We Know" information sheets. Teachers can use this site to support the answers to the "ADHD—Fact or Fiction?" preassessment.

Title: Mental Health: A Report of the Surgeon General

URL: <http://www.surgeongeneral.gov/library/mentalhealth/chapter3/sec4.html>

Description: This website provides an overview of ADHD from the United States Surgeon General. It covers topics such as the symptoms, diagnosis, neurobiology, and treatments of the disorder. This site can be used by teachers as a resource for additional information about ADHD.

Introduction

Duration: 15 minutes

To assess the students' initial understanding of neurotransmission and ADHD, the teacher should have them complete the "ADHD—Fact or Fiction?" preassessment. This can be done individually or in pairs, with the students having their own copies of the questions or one copy on a transparency. The teacher should collect their answers when they are finished and keep them until the end of the unit. The teacher should discuss the answers, or go over the answers as an introduction to the ADHD treatment debate in the Conclusion step.

Web Resource

Title: National Resource Center on AD/HD

URL: <http://www.help4adhd.org>

Description: This website provides information about ADHD including causes, myths, frequently asked questions (FAQ), and What We Know information sheets. Teachers can use this site to support the answers to "ADHD—Fact or Fiction?" preassessment.

Supplemental Documents

Title: ADHD—Fact or Fiction?

Description: This pretest can be used to assess students' understanding of ADHD. It can also serve as a springboard for discussion throughout the unit.

Title: Answer Key ADHD—Fact or Fiction?

Description: This is the answer key that can be used when checking the students' understanding of ADHD. The websites with the information to support each statement are provided on the document.

Step 2

Duration: 30 minutes

To learn about the structure of a neuron, students will work to build a virtual or physical model of a neuron, or both. Students may work individually or in pairs. The students building the virtual neuron will need access to a computer with Internet access, while the students building a physical neuron will need five different color pipe cleaners each. The students on computers should access the “Make a Mad, Mad Neuron” website and follow the directions. The students building the physical neuron should follow the directions on the “Building a Pipe Cleaner Neuron” worksheet. If no computers with Internet access are available, the teacher could direct all students to complete the “Building a Pipe Cleaner Neuron” activity.

Web Resource

Title: Make a Mad, Mad, Mad, Neuron

URL: <http://learn.genetics.utah.edu/units/addiction/reward/madneuron.cfm>

Description: This website from the Genetic Science Learning Center at the University of Utah contains an interactive module that students can use to build a virtual model of a neuron.

Supplemental Document

Title: Building a Pipe Cleaner Neuron worksheet

Description: This worksheet contains directions for building a model of a neuron using pipe cleaners.

Step 3

Duration: 45 minutes

Now that the students have investigated the structure of a single neuron, they will examine how two neurons work together to transmit a message by viewing an online animation of neurotransmission and completing a simulation of neurotransmission using construction paper. To view the animation, students will need access to computers with an Internet connection. Alternatively, the animation can be viewed using one computer and a projector.

First, the teacher should distribute the “The Way Neurons ‘Talk’” handout to each student. Students should fill out the handout while viewing the animation and completing the activity. Then, the teacher should show the animation on neurotransmitters found on the National Institutes of Health (NIH) website included in the Web Resources section and discuss the process of neurotransmission with the class, asking students to refer to details from the animation. The students will then demonstrate an understanding of neurotransmission by modeling neurotransmission using the “The Way Neurons ‘Talk’” activity.

For this activity, students will pair up. Each student an 8½” x 11” piece of white paper. The teacher will instruct one of the students in each pair to sketch the axon and an axon terminus of a neuron using the images from the animation for reference. The other student of the pair will be instructed to sketch the dendrites and cell body of a neuron on the second piece of paper. The students will then position their papers so that they are next to each other, but not touching, so that a synaptic space is formed. The teacher should check for understanding at this point by making sure the axon terminus of one neuron is facing the dendrite of the other. The students will be instructed to place the yellow construction paper circles (vesicles) on the axon terminus, the black paper circles (neurotransmitters) on the yellow circles, the green crescents (enzymes) in the synaptic space, and the blue rectangles (receptors) on the edge of the dendrites. As this is being done, the teacher will check to make sure all students have placed the pieces correctly.

When all students are ready, the teacher will tell them that the electrical impulse is traveling down the axon and has reached the vesicles (yellow). The teacher will also tell the students to move some of the neurotransmitters (black) out of the vesicles and toward the synaptic space and to continue moving the neurotransmitters across the synaptic space and into the receptors (blue) on the dendrites. After counting to 10, the teacher will then tell the students that the enzymes need to break down the neurotransmitters still in the synaptic space (moving the circles representing neurotransmitters to another part of the work space) or have the neurotransmitters move back into the vesicles, or both. When all neurotransmitters are out of the synaptic space, the teacher will ask each group to report on how many neurotransmitters made it to the second neuron, how many were broken down, and how many were reabsorbed. This information should be recorded on the board so it can be used in the next discussion.

At this time the students could repeat the process as needed, with minimal teacher interaction. The teacher should have the students set the neurons up again, start the process, and count to 10. They should be allowed time to remove the neurotransmitters as needed. This should be done with minimal instruction of what the details are at each step, or the students should explain what is happening at each step. The teacher should monitor the process occurring in each pair and guide the movement as needed.

Web Resource

Title: How Neurotransmission Works

URL:http://science.education.nih.gov/supplements/nih2/Addiction/activities/lesson2_neurotransmission.htm

Description: This NIH website features an animation of the process of neurotransmission. The animation can be shown to students as an illustration of how neurotransmission works. The site also has a written transcript of the narration for the animation.

Supplemental Documents

Title: The Way Neurons “Talk”

Description: This worksheet is for the students to use as they work through the animation of neurotransmission from NIH and the modeling activity.

Title: Answer key—The Way Neurons “Talk”

Description: This document is the answer key to the student worksheet

Title: Neuron and Neurotransmission Images

Description: This document provides a template for the “The Way Neurons ‘Talk’” activity.

Step 4

Duration: 15–30 minutes

Once the students have an understanding of normal neurotransmission, they will learn how that process is altered in ADHD. This will be done through a lecture and teacher-led discussion.

The teacher can use the included lecture notes to detail the changes in neurotransmission that occur in people with ADHD. Next, the teacher should have the students brainstorm which part(s) of the process could be addressed by medical treatments. (The parts of the process that could be involved are the quantity of neurotransmitter released initially, the amount of time the neurotransmitter spends in the synaptic space, and the efficiency of the receptor at moving the neurotransmitter into the second neuron.) Current treatments include stimulants such as Ritalin[®] and Adderall[®], which increase the amount of neurotransmitter released, and

nonstimulants such as Strattera[®], which delays the reuptake of the neurotransmitter, allowing more of an opportunity to reach the receptor.

Supplemental Document

Title: Neurotransmission and ADHD

Description: This document contains lecture notes for the discussion of ADHD and neurotransmission.

Step 5

Duration: 20 minutes

Now that students have mastered the anatomy of a neuron and the process of neurotransmission and have learned how that process is altered in people with ADHD, it is time to explore treatment options for ADHD. Before students begin their next activity, the teacher should review some basic understandings of ADHD. This can be done on the board, on an overhead, or as a discussion. The teacher can use the notes provided in the 'Basics of ADHD' to guide the lecture or discussion.

Supplemental Document

Title: Basics of ADHD

Description: This document contains lecture notes for the discussion of ADHD.

Conclusion

Duration: 3 hours

Following the discussion of ADHD, students will apply this knowledge to learn more about treatments for ADHD. The teacher should distribute a copy of the assignment sheet entitled "ADHD: The Treatment Debate" to all students. This assignment sheet lists 25 different characters who will be participants within the debate. Each student should be assigned a role in the debate. Each will research the role of his or her assigned character and support the character's opinion using scientific data and research. The students will be assessed using their presentations, their presentation notes, their participation throughout the debate, and a 1–to 2–page paper explaining the biology of ADHD. Students will be evaluated using the "ADHD: The Treatment Debate Rubric." This rubric should be given to the students before they begin their research so that they are aware of what to include in their essays and presentations. The teacher is meant to be an observer during the debate. Before the debates begin, the teacher should prepare a list of student names and make checkmarks next to each student when he or she participates in the debate with well-founded, scientifically valid arguments. Student participation grades should be based on these observations. Note: The time allotted to this step will vary greatly depending on the amount of time allocated to research during school hours. The procedures in this step should be adjusted according to the time available.

Web Resources

Title: National Resource Center on AD/HD

URL: <http://www.help4adhd.org>

Description: This website provides information about ADHD including causes, myths, frequently asked questions (FAQs), and "What We Know" information sheets. Students can use this site to research ADHD and the various perspectives on the ADHD treatment debate. All students, regardless of their assigned viewpoint, can use this site during the debate.

Title: Mental Health: A Report of the Surgeon General

URL: <http://www.surgeongeneral.gov/library/mentalhealth/chapter3/sec4.html>

Description: This website provides information from the United States Surgeon General concerning ADHD. It covers topics such as the symptoms, diagnosis, neurobiology, and

treatments of the disorder. All students regardless of their assigned viewpoint can use this site during the debate.

Title: MedWatch—2005 Safety Alerts for Drugs, Biologics, Medical Devices, and Dietary Supplements

URL: <http://www.fda.gov/medwatch/safety/2005/safety05.htm>

Description: The U.S. Food and Drug Administration provides safety alerts for many different types of medications on this website. All students, regardless of their assigned viewpoint, can use this site during the debate; however, it might prove to be more useful for roles that do not agree with medications as treatments for ADHD.

Title: American Academy of Pediatrics: Children's Health Topics: ADHD

URL: <http://www.aap.org/healthtopics/adhd.cfm>

Description: The American Academy of Pediatrics supplies information and resources for families and individuals that are affected by ADHD. All students, regardless of their assigned viewpoint, can use this site during the debate.

Assessment

The students will be evaluated by completing the "The Way Neurons 'Talk'" worksheet in step 3 and by preparing a paper and presentation and taking part in the "ADHD Treatment Debate" in the conclusion. Students will be graded on their paper, presentation, and debate participation using the "ADHD: The Treatment Debate Rubric".

Modifications

Extensions

Students could research other diseases that are affected by physiological changes within the neuron as well as a malfunction during neurotransmission (for example, adrenoleukodystrophy and Alzheimer disease). In addition, many different models of the neuron could be built (step 2) depending on time and resource allowances. Some examples can be found at the "Neuroscience for Kids" website that follows.

Web Resource

Title: Neuroscience for Kids

URL: <http://faculty.washington.edu/chudler/chmodel.html>

Description: This could be a possible extra credit or time activity depending on time and resources available. This includes directions for making a neuron model using beads.

Education Standards

National Science Education Standards

LIFE SCIENCE, CONTENT STANDARD C:

As a result of their activities in grades 9 through 12, all students should develop an understanding of

- **The cell**
- Molecular basis of heredity
- Biological evolution

- Interdependence of organisms
- Matter, energy, and organization in living systems
- **Behavior of organisms**

SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES, CONTENT STANDARD F:
As a result of activities in grades 9 through 12, all students should develop understanding of

- **Personal and community health**
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

State Standards

Illinois

IL.22.A.5c: Explain how health and safety problems have been altered by technology, media, and medicine (e.g., product testing; control of polio; advanced surgical techniques; improved treatments for cancer, diabetes, and heart disease; and worksite safety management).

IL.23.A STANDARD: Describe and explain the structure and functions of human body systems and how they interrelate.

North Carolina

NC-SCOS-05-06.SC.BIO.4.02.2: Transport, excretion, respiration, regulation, nutrition, synthesis, reproduction, and growth and development.

ADHD—Fact or Fiction?

Focus On This: The Biology of ADHD
Jessica Ogulnik and Laura M. Stiles, CDC's 2006 Science Ambassador Program

Identify each of the following statements as FACT or FICTION based on your understanding of ADHD.

- _____ 1. ADHD stands for Attention Disruptive Hyperactivity Disorder.
- _____ 2. More males than females are diagnosed with ADHD.
- _____ 3. ADHD is more common in children who have well-educated parents.
- _____ 4. All children who are identified with ADHD have a lower than average IQ.
- _____ 5. It is common for a child to develop symptoms of ADHD once in high school.
- _____ 6. A symptom of ADHD is an unorganized notebook.
- _____ 7. ADHD is not a formally recognized disorder and is, in fact, due to a lack of discipline.
- _____ 8. Children with ADHD will eventually outgrow it.
- _____ 9. Children with ADHD are always hyperactive.
- _____ 10. Children with ADHD cannot focus on any activity.

ADHD—Fact or Fiction? Answer Key

Focus On This: The Biology of ADHD
Jessica Ogulnik and Laura M. Stiles, CDC's 2006 Science Ambassador Program

Directions

Identify each of the statements as FACT or FICTION based on your understanding of ADHD

- FICTION 1. ADHD stands for Attention Disruptive Hyperactivity Disorder.
ADHD stands for attention deficit /hyperactivity disorder.
- FACT 2. More males than females are diagnosed with ADHD.
Males are more likely to be diagnosed with ADHD. Although females might have similar rates of ADHD, they might be less likely to be diagnosed (<http://www.help4adhd.org/about/myths>).
- FICTION 3. ADHD is more common in children who have well-educated parents.
Other factors such as educational/occupational status of parents do not appear to have a significant contribution to the development of AD/HD symptoms (<http://www.help4adhd.org/about/myths>).
- FICTION 4. All children who are identified with ADHD have a lower than average IQ.
ADHD does not discriminate on the basis of intelligence; though it is possible for a child with ADHD to have learning difficulties as a result of the disorder (<http://www.help4adhd.org/faqs.cfm#faq39>).
- FICTION 5. It is common for child to develop symptoms of ADHD once in high school.
For an official diagnosis of ADHD, the onset of symptoms must occur before 7 years of age (<http://www.help4adhd.org/en/about/what/WWK1>).
- FACT 6. A symptom of ADHD is an unorganized notebook.
Many children affected by ADHD—inattentive type have difficulty with organization (<http://www.help4adhd.org/en/about/what/WWK1>).
- FICTION 7. ADHD is not a formally recognized disorder and is in fact due to a lack of discipline.
ADHD is a real disorder recognized by the National Institutes of Health, the U.S. Surgeon General, and others (<http://www.help4adhd.org/about/myths>).
- FICTION 8. Children with ADHD will eventually outgrow it.
People can learn to manage the symptoms of the disorder but will not outgrow it (<http://www.help4adhd.org/about/myths>).

FICTION

9. Children with ADHD are always hyperactive.

Children diagnosed with ADHD can demonstrate attention difficulties without obvious hyperactivity (<http://www.help4adhd.org/en/about/what/WWK1>).

FICTION

10. Children with ADHD cannot focus on any activity.

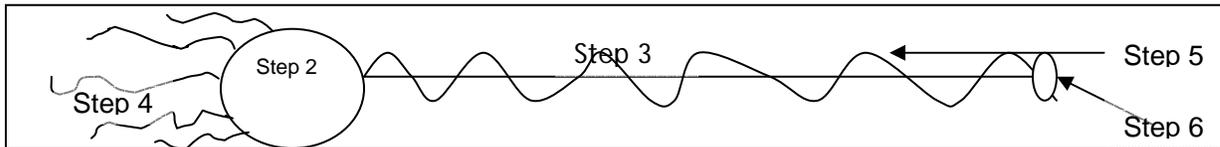
If the activity is something that a student enjoys he or she might not have any difficulty with focusing; difficulties exist when the student is engaged in tasks that are routine or uninteresting (<http://www.help4adhd.org/en/about/what/WWK1>).

Building a Pipe Cleaner Neuron

Focus On This: The Biology of ADHD
Jessica Ogulnik and Laura M. Stiles, CDC's 2006 Science Ambassador Program

Directions for students:

1. Obtain five different color pipe cleaners.
2. Form the first pipe cleaner into a circular shape to represent the cell body.
3. Curve the tip of a second pipe cleaner around the edge of the circle you just made to represent the axon.
4. Take a third pipe cleaner and cut it into five pieces. Attach each individual piece to the cell body created in step 2. These represent your dendrites.
5. Using a fourth pipe cleaner, attach one end to the axon made in step 3 and wrap the pipe cleaner along the entire length of the axon in a spiral. This will represent your myelin sheath.
6. Finally, using a fifth color, cut a small piece (approximately 2 centimeters) and wrap it around the end of the axon furthest from the cell body. This will represent the axon terminal.



References

1. Chudler, EH. Neuroscience for Kids. Models. Pipe Cleaner Neuron [online]. 2006. [cited 2006 Jun 14]. Available from URL: <http://faculty.washington.edu/chudler/chmodel.html>.

The Way Neurons “Talk”

Focus On This: The Biology of ADHD
Jessica Ogulnik and Laura M. Stiles, CDC’s 2006 Science Ambassador Program

Part 1—How is the message sent?

Before watching the computer animation, students should answer the following questions:

1. How do neurons relay messages—through chemical or electrical signals? In another way?
2. Should the message between neurons be short-lived or long-lived? Why?
3. What controls the length of time the message is available?

As you watch the animation:

4. Define the following terms:
 - a. Action potential
 - b. Vesicles
 - c. Neurotransmitters
 - d. Postsynaptic neuron
5. What are the two things that happen to the neurotransmitter once it has passed on its message?

Part 2—Modeling the way neurons “talk”

After you have modeled the movement of the neurotransmitters, summarize the process in three to four sentences, using the terms enzyme, axon terminus, vesicle, dendrite, receptor, synaptic space, nerve impulse, and neurotransmitter.

The Way Neurons “Talk” —Answer Key

Focus On This: The Biology of ADHD
Jessica Ogulnik and Laura M. Stiles, CDC’s 2006 Science Ambassador Program

Part 1—How is the message sent?

Before watching the computer animation, students should answer the following questions:

1. How do neurons relay messages—through chemical or electrical signals? In another way?
Communication between two neurons begins when an electrical impulse called an action potential travels along the axon of a presynaptic neuron toward the axon terminal. The action potential cannot cross the synaptic space. Instead, the action potential causes vesicles containing chemical messengers called neurotransmitters to be released. The neurotransmitters—chemical signals—bind to receptors that trigger an action potential.
2. Should the message between neurons be short-lived or long-lived? Why?
The longevity of the message varies depending on the type of message being sent. Some messages need to be short-lived, while others need to last longer.
3. What controls the length of time that the message is available?
The amount of time the message is available is controlled by the presence of the neurotransmitters in the synaptic cleft.

As you watch the animation:

4. Define the following terms:
 - a. Action potential—This is the electrical impulse that serves as the communication between the neurons.
 - b. Vesicles—A membranous sac that forms in the axon terminal; it forms when the action potential reaches the terminus.
 - c. Neurotransmitters—The chemical that is released from the vesicle and travels from the axon terminus to the dendrite.
 - d. Postsynaptic neuron—The neuron that receives the message/ neurotransmitter
5. What are the two things that happen to the neurotransmitter once it has passed on its message?
The neurotransmitter is either reabsorbed by the vesicles or broken down by enzymes in the synaptic space.

Part 2—Modeling the way neurons “talk”

After you have modeled the movement of the neurotransmitters, summarize the process in three to four sentences, using the terms enzyme, axon terminus, vesicle, dendrite, receptor, synaptic space, nerve impulse, and neurotransmitter.

A correct answer could include something like this:

When the nerve impulse reaches the vesicles in the axon terminus, neurotransmitters are released. The neurotransmitters travel out of the axon terminus and cross the synaptic space, heading for the receptors on the dendrite. Neurotransmitters that make it to the receptor move into the dendrite. Neurotransmitters that are left in the synaptic space are broken down by the enzymes or reabsorbed into the vesicles in the axon terminus, or both.

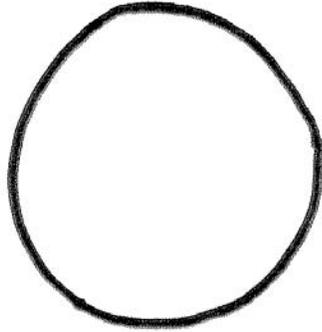
Neuron and Neurotransmission Images

Focus On This: The Biology of ADHD

Jessica Ogulnik and Laura M. Stiles, CDC's 2006 Science Ambassador Program

A template for the "The Way Neurons Talk" activity

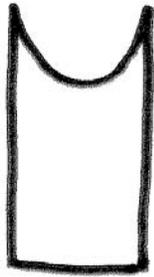




vesicle



neurotransmitter



receptor
for dendrite



enzyme in
synaptic space



Neurotransmission and ADHD

Focus On This: The Biology of ADHD

Jessica Ogulnik and Laura M. Stiles, CDC's 2006 Science Ambassador Program

I. Normal Neurotransmission

- A. Release of neurotransmitters
 - 1. Neurotransmitters are released from the presynaptic neuron when the electric impulse reaches the vesicles.
 - 2. The neurotransmitters then enter the synaptic space.
 - 3. After reaching the synaptic space, the neurotransmitters fit into the receptors on the postsynaptic neuron and move into the dendrite.

- B. Removal of neurotransmitters
 - 1. Neurotransmitters that are not moved into the postsynaptic neuron are broken down by the enzymes in the synaptic space, or
 - 2. Reabsorbed by the presynaptic neuron and returned to the vesicles to be used during the next impulse.

II. Neurotransmission in ADHD

- A. The signal does not pass efficiently from the presynaptic neuron to the postsynaptic neuron.
 - 1. One neurotransmitter thought to be involved is dopamine.
 - 2. The other neurotransmitter thought to be involved is norepinephrine.

- B. The parts of the process that could be affected
 - 1. It is possible that not enough neurotransmitter is being released.
 - 2. It is possible that not enough neurotransmitter is being received.

- C. Targets of potential medical treatments
 - 1. More neurotransmitter could be released—this is the role of stimulants such as Ritalin[®] and Adderall[®].
 - 2. Less neurotransmitter could be reabsorbed or broken down, allowing it to stay in the synaptic space longer and increasing the chance of entering the postsynaptic neuron. This is the role of nonstimulants, such as Strattera[®].

References

Visser, Susanna. Childhood Attention-Deficit/Hyperactivity Disorder. Presented at: CDC Science Ambassador Program; June 2006, Atlanta, GA.

Basics of ADHD

Focus On This: The Biology of ADHD
Jessica Ogulnik and Laura M. Stiles, CDC's 2006 Science Ambassador Program

I. Basics of ADHD

A. Definition and prevalence

1. According to the Centers for Disease Control and Prevention (CDC), ADHD is a common neurobehavioral disorder of childhood and can persist through adolescence and into adulthood.

2. American Psychiatric Association's Diagnostic and Statistical Manual-IV, Text Revision (DSM-IV-TR) has estimated that 3% to 7% of children have ADHD.

B. Causes

1. There is no known cause of ADHD.

C. Symptoms

1. There are many different symptoms of ADHD. The CDC ADHD website lists several symptoms a child might exhibit including, but not limited to:

a Inattention

- i Is easily distracted
- ii Has trouble organizing activities
- iii Is often forgetful in daily activities

b Hyperactivity

- i Talks incessantly
- ii Often fidgets with hands or feet
- iii Is often "on the go"

c Impulsivity

- i Often has trouble waiting his or her turn
- ii Often interrupts others
- iii Often blurts out answers before questions are finished

2. A trained professional is required to make a diagnosis of ADHD. Health care professionals will assess whether a person exhibits enough of the symptoms to be diagnosed.

3. A diagnosis requires six or more symptoms to be present in either the Inattention, Hyperactivity, or Impulsivity categories for at least 6 months, and that are disruptive and inappropriate for developmental level.

D. Types

1. Predominantly Inattentive Type: According to the CDC, this type is characterized by an individual who has difficulty:

- a Organizing or finishing a task
- b Paying attention to details
- c Following instructions or conversations

This person can also be easily distracted or forget details of daily routines.

2. Predominantly Hyperactive-Impulsive Type: According to the CDC, this type is characterized by an individual who:
 - a Fidgets and talks a lot
 - b Has a hard time sitting still for long (e.g., for a meal or while doing homework)
 - c Feels restless and has trouble with impulsivity
 - d Might interrupt others a lot, grab things from people, or speak at inappropriate times
 - e Might find it hard to wait his or her turn or listen to directions
 - f Might have more accidents and injuries than others without ADHD
3. Smaller children might run, jump, or climb constantly.
4. Combined Type: According to the CDC, this type exhibits characteristics from both Predominantly Inattentive and Predominantly Hyperactive-Impulsive individuals.

References

American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision. Washington, DC: American Psychiatric Association; 2000.

Centers for Disease Control and Prevention. Attention-Deficit/Hyperactivity Disorder [online]. 2005. [cited 2006 July 26]. Available from URL: <http://www.cdc.gov/ncbddd/adhd/what.htm>.

ADHD: The Treatment Debate

Focus On This: The Biology of ADHD

Jessica Ogulnik and Laura M. Stiles, CDC's 2006 Science Ambassador Program

Recently, students have been learning about the nervous system, neurons, and neurotransmission. ADHD is a condition of the nervous system. Sometimes medications including stimulants are used in the treatment of ADHD. Some people feel that medications are very helpful for treating ADHD, while others feel that medications should not be used or that their use should be limited in the treatment of ADHD. The teacher should have the class debate this topic. Each student should be assigned a role and research the debate from the perspective of that role. In order to form an opinion, each student will have to research the topic assigned and prepare an argument to present to the class.

Possible Positions

Directions

The teacher should assign each student one of the following roles within the debate. Some of the positions are somewhat controversial, and students might or might not agree with the role assigned. Students should be reminded not to argue by presenting personal opinions or anecdotes, but rather by presenting information collected through research based on the assigned point of view.

U.S. Food and Drug Administration (FDA) 3 Students—As head of the FDA, it is your responsibility to be informed on both sides of the issue so that you can supervise the meeting discussing the possible treatments of ADHD. You will be responsible for making the final decision on what the federal government will recommend.

Pharmaceutical Company Representative #1—As the head of a pharmaceutical company, you are concerned with the safety of your products, as well as keeping your company's best interests in mind. Your company is a relatively young one, and your ADHD drug is one of only a few products that you sell.

Pharmaceutical Company Representative #2—As the head of a pharmaceutical company, you are concerned with the safety of your products, as well as keeping your business' best interests in mind. Your company is well established, with billions of dollars of revenue annually.

Artist—You actually see ADHD as an asset to your career. You are able to be incredibly creative and pursue many different outlets, which has allowed you to become a successful artist. You believe that children should not be medicated, and feel that medication has the power to stifle children's creative abilities.

CDC Epidemiologist—As an epidemiologist, it is your job to study diseases, determine their causes and incidence, and propose a way to control the diseases. Using research, propose a plausible treatment program that would be supported by CDC in Atlanta, GA.

Parent of a 3-Year-Old With ADHD—As a parent you are incredibly concerned with the health of your child. Your son has been diagnosed with ADHD. You are obviously interested in all of the possible treatments for this condition and want to figure out which therapy or combination of therapies you should pursue.

Teenager Using Medication #1—You have been using ADHD medication for the past 8 years. Although the medication has, in fact, improved your performance academically, it does have one side effect that is difficult to manage: you have developed a tic as a side effect of the medication. The tic has affected your social situation at school.

12-Year-Old Using Medication—You have been taking ADHD medication. Previously, you experienced lack of concentration, were unable to process what was being said when spoken to directly, and were easily distracted. You have had a positive experience with medication and you are having an easier time in school and at home.

Grieving Parents 2 Students —Your child died recently of a myocardial infarction during a basketball game. You and your child's pediatrician suspect that the infarction was caused by the recent introduction of an ADHD medication. You have recently learned of similar reports that have been made to the U.S. FDA, and you are angered that your child's doctors did not perform a cardiac screening before prescribing the ADHD medication. You are determined to make sure that, in the future, people are warned before taking medicine for ADHD.

Individual Who Does Not Believe in ADHD—You are an individual that believes who there is a lack of scientific proof that ADHD exists as a medical condition. You believe that ADHD medication is an excuse for society to drug children instead of dealing with the root of their problems.

Teacher #1—You are a teacher and have seen the incredible difference that ADHD medication can make with students diagnosed with the condition. You strongly believe that students benefit from ADHD medication and that all of your students with ADHD should include medicine in their treatment regimen.

Teacher #2—You are a teacher who thinks that ADHD medication is overprescribed to the public. You believe that if parents at home were to spend more time with students and if proper attention and discipline were administered, then fewer children would exhibit the symptoms of ADHD and need to be medicated. You are upset that some parents choose to medicate their child but do not investigate other treatment options.

School Administrator—You are in charge of disciplining students at the high school. You have noticed that students who have been diagnosed with ADHD and take medication are much less likely to cause disruptions within the classroom. You are in favor of endorsing ADHD medication as part of an ADHD treatment plan.

Physical Education Teacher—You have not noticed any problems with students with ADHD in your class. The students usually participate well within your classroom, and you do not observe the same behaviors as your colleagues who teach other subjects. You are interested to see how students with ADHD act when engaged in various types of activities.

Behavioral Therapist- You are responsible for working with children who have been diagnosed with ADHD and their parents. You believe that behavioral therapy is necessary for all children with ADHD, regardless of whether or not their parents choose to have them take prescription medication..

Older Sibling of an Individual With ADHD—You have seen your younger sibling receive a diagnosis of ADHD and begin treatment. Your parents previously spent a lot of time disciplining your younger sibling, and since beginning treatment, your parents have been much more

cheerful and attentive to you overall. You believe that the treatment for the ADHD has improved your overall quality of life.

Younger Sibling of an Individual With ADHD—Your older sibling was diagnosed as having ADHD and has been taking a prescribed stimulant to reduce symptoms of ADHD. Your sibling has developed high blood pressure and an increased heart rate and has lost a lot of weight. You are concerned for your sibling's health and believe that the ADHD medication is responsible for your sibling's health changes.

Best Friend of an Individual With ADHD—Your best friend is one of the top students of your class. Your friend has been receiving treatment, including medication, for his or her ADHD since he or she was in elementary school. You really like your friend and, therefore, are a supporter of his or her treatment choices.

Employer—You are the manager of a local fast food restaurant that employs many local teenagers. You find that you employ a few teens who have trouble focusing on tasks at hand, have difficulty showing up to work on time, and sometimes have a hard time listening well to your customers. You believe that they might benefit from being treated for ADHD.

Pediatrician—You are responsible for explaining the physiology of ADHD and summarizing reasons why people might choose to include or not include medication for ADHD in their treatment plan. Make sure to explain all of the various types of treatment available for this condition.

Parent Who Might Have ADHD—You have always believed yourself to have ADHD. You think that had you been diagnosed earlier in life you would have been much more likely to have held on to employment and been a more successful member of society. You now have a child with ADHD and believe that treatment will greatly improve your child's chances of success.

Media—You are responsible for recording the happenings at the debate. You should also be prepared to ask the participants questions. You will need to have knowledge of all possible stances in order to pose questions.

Your assigned role is: _____

Some Points To Guide Student Research

Instructions for students in researching roles

1. What is ADHD? Include the history of the disorder and the biological process that is thought to be involved.
2. How does ADHD treatment affect your character's life directly?
3. Include at least **four** of the following terms as well as **three** sources.
ADHD Neuron Drug treatment
Neurotransmission Synapse Nervous system
Neurotransmitter Prevalence Behavioral Therapy
4. If you are for or against using medication to treat ADHD, you must support your argument using your research from your sources. Be sure to list your sources!

Your Assignment

- You are to answer the previous questions and use those answers to write a **1– to 2–page position statement** from your character's perspective.
- Prepare a **note card** with your position summarized in one or two sentences. List **7 to 10 facts** supporting your argument (these should come from your paper).
- **Participate in a discussion** at the FDA and help determine the agency's stance on treatments for ADHD

**ADHD: The Treatment Debate
Position Paper Rubric**

	4	3	2	1	
What is ADHD?	Student supplies a comprehensive definition in his or her own words	Comprehensive definition, but student does not demonstrate full understanding	Definition missing details/ required information	Student does not understand concepts	
History and Biology of ADHD	Student adequately describes history and biology with his or her own words	Student does not understand the biological process or does not mention history	Not an adequate description of the history or biological concepts	Student shows no understanding of biology behind the concepts	
Impact of ADHD on Your Character	Thoughtful response, includes emotions, creativity is shown	Thoughtful response, not as creative with description	A few points, not very thoughtful or creative	Student restates the character description, no new descriptions offered	
Use of Four Required Terms	Four terms	Three terms	Two terms	One term	
Support of Opinion With Scientific Facts	A fair and thoughtful response based on his or her character's position, backed with research	Student's response includes some personal opinion, not totally backed with research	Not complete responses, personal opinions included	No connection evident between student's statements and character's position	
Grammar and Spelling	No errors	1-2 spelling errors	3-4 grammar and spelling errors	5-6 errors, Hard to read	
Length and Flow	2 pages, flows well	1-2 pages, flows well	1 page, lack of flow	1 page, no flow	

**ADHD: The Treatment Debate
Debate Participation Rubric**

	4	3	2	1
Description of Position Statement	Complete description, including character history as well as research	Gives a description, but connection between history and research is not made	Description lacking either history or research	Poor description
Support of position statement	8-10 facts supplied	5-7 facts supplied	3-4 facts supplied	1-2 facts supplied
Debate Responses/ Posing Questions	Speaker displays maturity and responds with factual arguments and logic	Emotion interferes with factual arguments	Not many facts evident, strictly emotional responses	Minimal involvement during debate, does not respond to others
Clarity and Volume	Clear and Loud	Clear but difficult to hear from time to time	Lack of clarity and volume	Very difficult to hear and understand

Paper _____/28 Points

Notecard _____/ 6 Points

Debate _____/16 Points

TOTAL _____/50 Points