The Physiology of Addiction

Document Overview

Within this document, you will find a connection to the MN state standards, Next Generation Science Standards, activity objectives, type of activity, duration of activity, connection to the Nobel Conference 2015 speaker, keywords/concepts, target audience, description of activity, materials list, teacher tips, the activity, extensions, follow-up activities, and reference section.

Standards

Minnesota State Academic Science Standards

- 7.4.1.1.1 Recognize that all cells do not look alike and that specialized cells in multicellular organisms are organized into tissues and organs that perform specialized functions.
- 9.4.1.1.1 Explain how cell processes are influenced by internal and external factors, such as pH and temperature, and how cells and organisms respond to changes in their environment to maintain homeostasis.
- 9.4.4.2.4 Explain how environmental factors and personal decisions, such as water quality, air quality and smoking affect personal and community health.
- 9.1.3.4.3 Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results

Next Generation Science Standards

- MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
- MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Other Standards:

Objective

To be able to explain how drugs affect the biochemistry of the brain.
To understand the physiological cause of addiction, withdrawal, and tolerance.

Type of Activity

Game/Simulation

Suggested Duration

45 minutes plus extensions

Connection to Nobel Speakers

Eric Kandel- Neuropsychiatrist

Marc Lewis- Developmental Neuroscientist

Concepts/Keywords/Appropriate Classes

Addiction, Tolerance, Withdrawal, Neurotransmitters, Neuron

Description of Activity

Students will partake in a game to simulate how drugs affect the brain's biochemistry

Materials

Ping pong balls

Masking tape
A basket/bag for each "vesicle"

Teacher Tips

You can set the activity up somehow to block the ping pong balls from crossing INTO the next neuron or just explain that they can't cross the membrane by themselves so the students need to prevent that from happening.

Students should have background knowledge on neuron anatomy and physiology

Activity

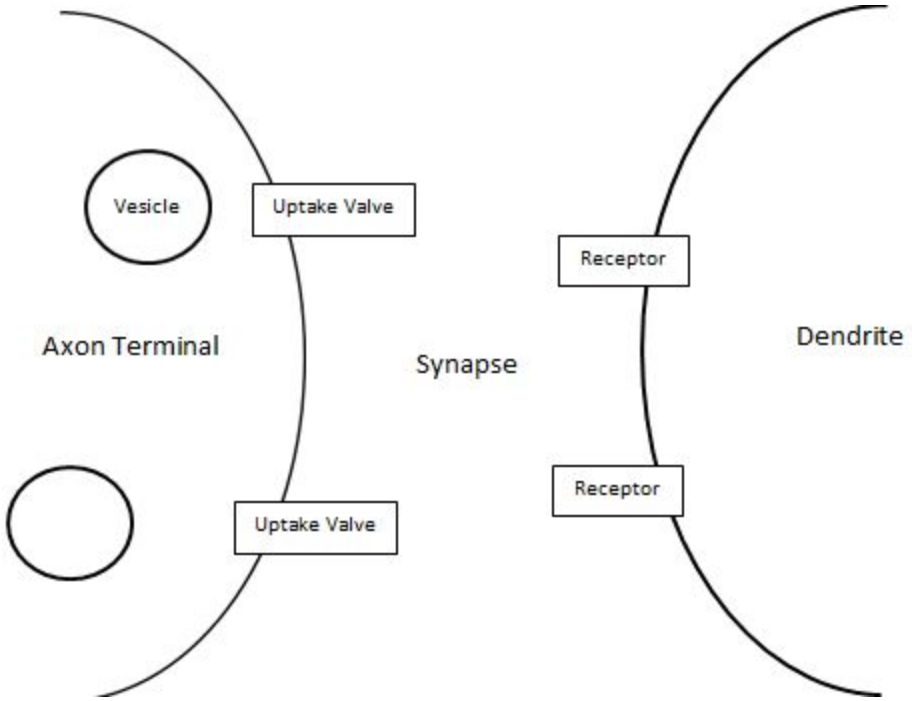
Lesson Plan: Addiction and the Brain Physiology

Essential Question: What causes addiction in the brain?

Activity: Synapse Simulation

Show SciShow Addiction https://goo.gl/0LYz1m

(Note: May be used pre or post lab (depending on how much you want them to uncover on their own through the activity)



Pre class set up: Using masking tape (or aligning your desks), create two curved boundaries in the middle of your classroom in the formation shown above. The left side represents the axon terminal of the presynaptic neuron and the right side represents the dendrite of the postsynaptic neuron. Have the two tape curves approximately 6 feet apart. This space represents the synapse.

Recommendation: Print off name tags for each role. Students will wear the name tags around their necks to keep them aware of who represents what.

In Class:

Assign equal numbers of kids to represent vesicles, uptake valves, and cocaine (example: 5 of each). Divide the remaining kids into 2 groups. Group one are postsynaptic receptors, group two will be added in later as additional receptors after the drug has been present in the system.

Carrying out the activity: (optional script)

Teacher- "You each have a goal. If you are a vesicle, your job is to dump the neurotransmitter (ping pong balls) into the synapse when I tell you to. If you are a receptor, your job is to get a ping pong ball once they are released, without leaving your spot, and then toss it to an uptake valve. Uptake valves pass the ping pong ball back to the vesicle where they are stored. This will continue until all ping pong balls are collected.

(Carry this out a couple of times. On the 2nd or 3rd time through, ask students to attempt to explain what is occurring)

Teacher- "The vesicles release the ping pong balls when something good happens. You just _____" (choose an example of an event such as taking a bite of their favorite food, or getting a text from someone that they have a crush on) "so your brain is going to release a chemical called dopamine. Dopamine is one of at least 100 different types of known neurotransmitters that send different messages in your brain when released. Dopamine gives a feeling of satisfaction or happiness."

(You can stop here assuming you have already learned about neuron signal transmission or go more in depth).

Teacher- "Once dopamine is released by the vesicles into the synapse, it is felt by the receptors on the receiving dendrite. As long as the dopamine continues to touch the receptors, a feeling of satisfaction/happiness is present. "When you ___action used before___ do you feel happy about it forever or does the feeling subside?"

(Discuss how the vesicles eventually stop releasing the dopamine and homeostasis returns).

Teacher- "Cocaine interferes with this natural process. Let's look at how."

(Show mouse party cocaine http://goo.gl/ePxYuq).

Teacher- "Let's see if we can act out the effects of cocaine on your brain's functioning. We are going to add in cocaine representatives who are going to block the uptake valves allowing the neurotransmitter (ping pong balls) to remain in the synapse. For the purpose of this simulation, the cocaine will continue to toss neurotransmitters back to the receptors on the postsynaptic cell."

(Vesicles, release the dopamine (neurotransmitter) and receptors catch them and toss them back to the uptake valves, but the cocaine blocks this interaction (and toss it back to the receptors)---HIGH STIMULATION for the receptors.)

Teacher- "Now, we will add in a 2nd group of receptors. This happens because the cocaine is blocking the uptake valves. So, the body senses a need for more receptors to interact with all of the excess neurotransmitter (ping pong balls) in the synapse. (homeostasis)"

Teacher- "Eventually the cocaine will break down and the uptake valves will be available to catch the dopamine again and pass it to their group's vesicle."

(Have the students representing the cocaine step out to the side and allow the tossing and catching to continue with the uptake valves now passing the balls to the vesicles. As a

receptor you are not happy when dopamine is released and you are not able to "catch it". This results in a deep urge to get the drug back in the system: ADDICTION.)

Follow up discussion:

Withdrawal- those receptors not feeling fulfilled for a substantial amount of time. How does one eventually pass through withdrawal? The body will respond (homeostasis) to the changing conditions by reabsorbing the excess receptors.
Tolerance- As the receptors increase in number, your body does not get the same feeling of content/happiness from the same amount of drug. More is needed to get that feeling.
Addiction- The need to find continued stimulation of the cells by any means necessary.

Risks of becoming addicted?

Extension question (upper level): Is this simulation an accurate demonstration for what is actually happening? Why or why not? Look up "chasing the high"
http://www.methproject.org/answers/what-is-chasing-the-high.html#Ring-the-Bell

Extension and Follow-up Activity

Extensions-

Questions:

1. When looking at the liver cells of an alcoholic, why would there be an increase in the number of smooth E.R. organelles in the cells?
2. What things other than drugs can people become addicted to? Why do you think that happens?

Read the following article: http://goo.gl/iLWnqk

3. Explain why people become addicted in a physiological sense. Discuss the structures in the brain and how their functions and locations drive addiction and memory.
4. Why do things as simple as eating a piece of cake or pizza trigger the release of dopamine, evolutionarily?

Divide kids up into small groups and assign them a drug to learn about using mouse party (http://goo.gl/ePxYuq) Have them fill in the appropriate section on the attached sheet and then modify the simulation that was completed in class to show how the drug assigned affects the brain. Have them share with the class.

Worksheet: http://goo.gl/OJUy61

Additional resource: http://ocw.mit.edu/ans7870/SP/SP.236/S09/lecturenotes/drugchart.htm

Sources/Bibliography

The Chemistry of Addiction. (n.d.). Retrieved June 30, 2015, from https://www.youtube.com/watch?v=ukFjH9odsXw

Mouse Party. (n.d.). Retrieved June 30, 2015.

Understanding Addiction. (n.d.). Retrieved June 30, 2015.

Fallows, Z. (n.d.). Neurotransmitters and Drugs Chart. Retrieved June 30, 2015.

Ping Pong Balls, available at Target Stores for about $10/36 balls.