

Script for the
Virtual Cocaine Lab
Tutorial

Professional
Development for
Teachers



**THE MIND
PROJECT**

<http://www.mind.ilstu.edu>

Introduction

Welcome to The Mind Project Website. This podcast provides professional development for teachers considering implementing “The Virtual Neuroscience Lab #1: Cocaine Study,” a free virtual lab available from The Mind Project. Our goal in this online tutorial is to provide teachers around the world with the introductory training that we offer in our face-to-face workshops.

Topics Covered in the Virtual Cocaine Lab

This tutorial will cover the following topics:

- A brief History of The Mind Project
- Benefits this lab provides to students
- Science content topics covered in the Virtual Lab
- Lab objectives aligned with standards
- Introduction to Dr. Garris, our scientist partner for this virtual lab.
- Implementation Suggestions and tips [range from how to integrate the virtual lab into your curriculum as well as curricular resources we have available for you, to tips and resources of how to assess students who have completed our lab.
- And the tutorial ends with Tips for Getting Started

Background on The Mind Project

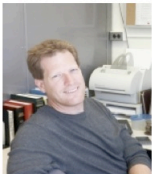
The Mind Project has created interactive, inquiry-based virtual laboratories that expose students to cutting edge science which apply to content they learn in the classroom. Our virtual labs are designed with several purposes in mind. One is to bridge the gap between research science and classroom science. We want to help teachers and their students, feel more connected with how science is conducted in the academic and industrial settings. We also want to expose students to exciting career options in science, particularly in research. The Mind Project provides a dynamic scientific experience that generously welcomes students into the dramatic center of scientific discovery.

The “who” behind The Mind Project



**Dr. David
Anderson**

Director (PI)
Philosophy
Professor at
Illinois State
University



**Dr. Paul
Garris**

Neurobiologist
at ISU



**Dr. Rob
Stufflebeam**

Director (PI)
University of
New Orleans

The Mind Project is made up of both university faculty and classroom teachers. Dr. David Anderson is the creator of The Mind Project and is a philosophy professor at Illinois State University. Dr. Paul Garriss is the neurobiologist who conducts the research on which the virtual Cocaine Lab is based. Dr. Rob Stufflebeam is a professor at University of New Orleans and worked with David on the creation of this lab. Dr. Darci Harland and Elisa Palmer are classroom biology teachers who were brought in to develop curriculum and professional development so that the lab could be used as part of 6-12 curriculum.

We are glad you are learning more about The Mind Project and we look forward to you joining the hundreds of other teachers who have become part of The Mind Project Team.

Introduction to the Virtual Cocaine Lab

Experience this Lab Offers

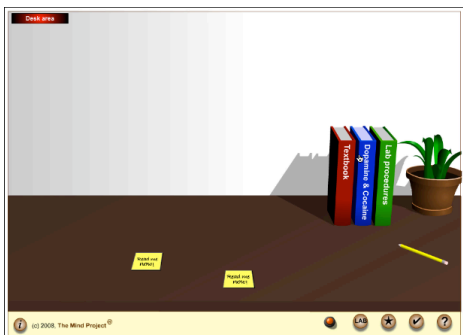
This virtual laboratory experience was designed to provide a fun and engaging way for students to learn about brain physiology and the biochemistry of neurotransmitters. However, we didn't want just to convey "facts" but to invite students into a study that pushes the edge of what is known about the relationship between cocaine use and the neurotransmitter dopamine.

The Student Role

In this virtual Cocaine Lab, students role-play a neurobiologist in midst of a controversy. It is well known that when cocaine reaches specific parts of the brain, it is accompanied by a large spike of the neurotransmitter, dopamine. What was not known until recent studies, is the role dopamine plays in the cocaine-seeking phase.

Students, as neurobiologists, conduct a virtual rat experiment to make connections between rat behavior and changing levels of dopamine. Specifically, students look for spikes in dopamine in a rat's brain with a rat that is trained to self-administer cocaine.

Reading



Before students begin conducting their virtual experiment, there are three virtual books that students must read. To make this more convenient, these virtual books are also available as a pdf that you can distribute to your students to read before they enter the virtual lab. However, we recognize that asking students to read pages of text before doing the lab takes some of the fun out of the experience. Therefore, a video tutorial titled, *Virtual Cocaine Lab Tutorial: Background on Dopamine and Cocaine*, is available on our website that students can watch instead of, or in addition to completing the readings. If students have access to headphones and speakers and



Dr. Darci
Harland

Curriculum and
Professional
Development
(Co-PI)



Elisa
Palmer

Curriculum and
Professional
Development

can watch the video – or if you can show the video to the class as a whole, it is not essential that students read the virtual textbooks.

Concepts Addressed in the Virtual Cocaine Lab

As a teacher who is considering implementing this virtual lab, you may be asking, “what science topics are covered in this lab?” so that you can determine where in your curriculum this lab will best fit. In a moment I will share with you the specific science concepts included in this virtual lab. But first I want to share with you more general concepts that the lab provides.

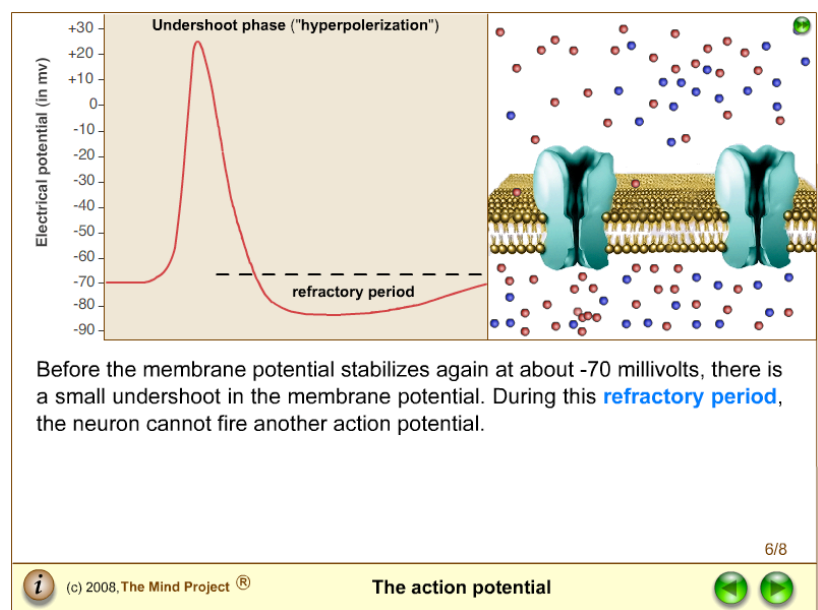
Teachers who have had students complete this lab are most appreciative of the strong research design that it models for students. Students see how hypotheses and predictions are tested in an experiment, and then how the data are used to support or reject the hypothesis. While rat research or types of behavior may not be topics that you cover in your curriculum, in context of drug addiction, students are exposed to how health, psychology, biology, and societal issues all overlap. Students also gain a glimpse of how important research is in the advancement of scientific knowledge.

Concepts Covered in Book 1: Background

More specifically, the Virtual Cocaine Lab addresses specific scientific topics that will overlap with topics you already teach. As previously mentioned there are three virtual books in the desk area, which is where students gain the necessary background to complete the virtual lab. [The information in these books is also provided in the "The Virtual Cocaine Lab Tutorial: Background on Dopamine and Cocaine."]

The topics addressed in the red book include:

- Nervous system anatomy including brain anatomy as well as neuron structure
- Neuron structure and conduction (This includes labeled diagrams of neurons as well as animated graphics of an action potential.)
- Differing types of synapses (Including electrical and chemical)
- An animated graphic showing the classic model of a chemical neurotransmission
- Comparative anatomy of human and rat nervous systems

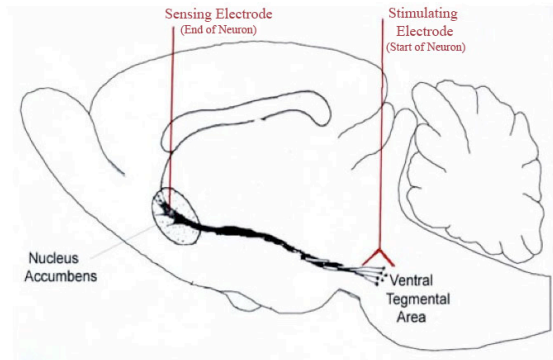


As you can tell, this first book gives a general introduction of neuron anatomy and physiology. This content is not required for doing the lab, and if students have already learned about this, you may choose to have students start their reading in book 2.

Concepts Covered in Book 2: Dopamine and Cocaine

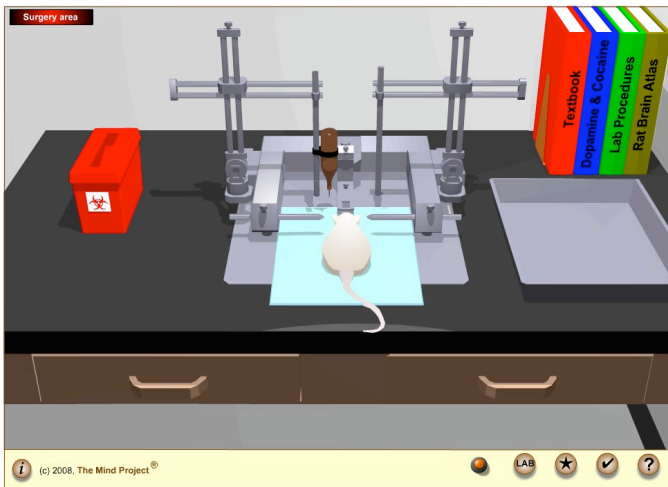
The topics addressed in the blue book titled, “Dopamine and Cocaine” include:

- Dopamine neuron function (which compares dopamine neuron with classical neuron function)
- Dopamine neuron system (to compare rat and human brain anatomy)
- Ways to measure levels of neurotransmitters
- Types of motivated behavior (including consummatory and appetitive phases)
- Intracranial self-stimulation (including dopamine’s role in the seeking of rewards)
- The role of Dopamine and drugs of abuse (including how rats are trained for experimentation, and what is already known about dopamine’s connection with cocaine use)



Therefore, this 2nd book will help your students connect what they already know about neurons, and determine how these cells are affected by cocaine use. The introduction of studying the brain of rats to learn more about dopamine is of high interest to students.

Concepts Covered in Book 3: Lab Procedures



The topics addressed in the green book titled, “Lab Procedures” is how students acquaint themselves with the purpose of the virtual lab. In this book they will learn the:

- Objectives, hypothesis and predictions
- Technical issues (including what technology is used to measure dopamine levels in the brain)
- Experimental Design [as it applies to this experiment and]
- Procedures of what they will do in the lab

The material in Book 3 is required for successfully doing the lab, however, as previously mentioned, we have included all of the essential content in the video, “*Background on Dopamine and Cocaine*” which you may have your students watch instead of reading the virtual book.

National and State Standards

Completing this lab meets inquiry standards as suggested the 1996 National Science Standards.

As a result of activities in grades 9-12, all students should develop abilities necessary to do scientific inquiry and develop understanding about scientific inquiry. (National Science Education Standards (1996). Center for Science, Mathematics, and Engineering Education (CSMEE).

Common Core Science Framework

This lab also aligns with all three dimensions of the Common Core Science Framework.

In the first dimension, “Scientific and Engineering Practices,” this lab provides the opportunity for students to ask questions, to carry out an investigation, and to analyze and interpret data.

In the second dimension, “Crosscutting Concepts” students are provided the opportunity to search for patterns in data, decipher cause and effect of the cocaine injections on dopamine levels in the brain, and to determine the impact of the structure and function of neurons in the brain.

And in the third dimension, “Disciplinary Core Ideas” this virtual lab addresses the Life Science core concept, “from molecules to organisms: Structures and processes.”

Illinois State Learning Standards

Since this virtual lab was developed in Illinois, we have aligned the content addressed in this lab with the Illinois State Learning Standards. [You can get a closer look at these standards by downloading the pdf script of this tutorial or the pdf of the professional development manual available on our website.]

If you are not from Illinois you will easily be able to align these with any of the other state standards.

Feel free to send us the standards from your state, that are met by this lab. We will post them for other teachers to use and give you credit (if you want) – you can even get your own profile on our website.

IL.11.A.4b: Conduct controlled experiments or simulations to test hypotheses.

IL.11.A.5c: Conduct systematic controlled experiments to test the selected hypotheses.

IL.13.A.4b: Assess the validity of scientific data by analyzing the results, sample set, sample size, similar previous experimentation, possible misrepresentation of data presented and potential sources of error.

IL.13.A.3c: Explain what is similar and different about observational and experimental investigations.

IL.13.A.5c: Explain the strengths, weaknesses and uses of research methodologies including observational studies, controlled laboratory experiments, computer modeling and statistical studies.

IL.13.B.5d: Analyze the costs, benefits and effects of scientific and technological policies at the local, state, national and global levels (e.g., genetic research, Internet access).

IL.22.A.5a: Explain strategies for managing contagious, chronic and degenerative illnesses (e.g., various treatment and support systems).

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; worksite safety management).

IL.23.B.2: Differentiate between positive and negative effects of health-related actions on body systems (e.g., drug use, exercise, diet).

IL.23.B.3: Explain the effects of health-related actions upon body systems (e.g., fad diets, orthodontics, avoiding smoking, alcohol use and other drug use).

Cocaine Lab Student Objectives

Integrating our Virtual Labs is made flexible by focusing in on the content that you want students to learn. While there are many different content objectives, by choosing how you introduce the lab, and how much upfront reading/preparing students do, you can focus students on the topics that best supplement the curriculum you want them to learn.

These objectives are also available for you in the professional development manual available on our website.

Students who complete the Virtual Cocaine Lab should be able to:

Identify parts of the brain involved with motivated behavior.

Explain how neuronal signaling works using the following terms: action potentials, synapses, axon, dendrite, cell body, axon terminal, ions, resting potential, neuro-transmitters, presynaptic neuron, and postsynaptic neuron.

Keep a virtual notebook of readings they have done within the lab by answering questions prompted within the notebook.

Read the lab procedures and be able to explain why each step of the procedure is completed.

Calculate the amount of anesthesia a rat should be given based on its weight in grams.

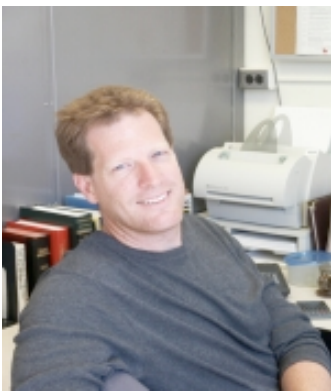
Observe a rat undergo surgery to implant a wireless telemetry system in its brain so that dopamine levels can be measured while it is freely moving.

Monitor a rat's behavior and dopamine levels during cocaine self-stimulation in order to collect data for the experiment.

Determine whether the data collected supports or rejects the hypothesis that dopamine is involved in cocaine seeking.

Describe in their own words how cocaine becomes addictive.

Introduction to Dr. Paul Garris



Dr. Paul Garris is a neurobiologist whose research on dopamine is what inspired several Mind Project virtual laboratories. Dr. Garris works at Illinois State University, and does current research on Parkinson's disease, drugs of abuse, dopamine signaling, and microsensor instrumentation development.

To learn how realistic the virtual lab is compared to the procedures currently used in Dr. Garris' lab, watch the video tutorial titled, "Background on Dopamine and Cocaine." In addition to the Cocaine Virtual Lab, Dr. Garris is the lead scientist behind other Mind Project labs including Parkinson's and Deep Brain Stimulation. An interview podcast with Dr. Paul Garris is also available to help you and your students feel connected to the research experience.

Implementation Tips: Getting Started

There are two video tutorials that you can watch in preparation for using this lab with your students.

The first tutorial is an overview of the virtual lab experience. This overview will provide navigation suggestions, and will introduce you to the four main areas within the lab, those being; the desk area, the prep area, the surgery area, and the experimental area. We also recommend that your students view this tutorial before they begin the virtual lab.

The second tutorial is one that will provide background of the neurobiology content on which the lab is based. It includes topics such as, role of neurotransmitters, dopamine neurons, motivated behavior, connections between dopamine and cocaine use, rat research, and an explanation of the experimental design. This tutorial is a condensed version of the three books that are found in the desk area. After comparing the video tutorial with the virtual books, you can choose the combination that will best help your students meet the objectives.



Complete the lab yourself!

After you have watched both tutorials, the next step is to participate in the virtual lab as if you were a student. This will help you to not only get a feel for what your students will experience, but also help you determine the best method of implementation, as well as calculating the time it takes to complete the lab.

Methods of Implementation

There are several ways to use the lab with students.

- 1) The first is individually, with each student at a computer. If you plan on completing this in a computer lab, note that there is sound associated with the tutorial and the lab. While sound is critical for watching the tutorials, it is not critical for completing the virtual lab. Therefore, you may want students to have headphones if they are listening to the tutorial, but having the sound shut off for the virtual lab is sufficient.
- 2) Second, you could also have students work in pairs or in groups. This reduces the number of computers you need to have and encourages collaboration.
- 3) Last, you could complete the lab corporately as a class using a projector. This allows you to have more control of how long the activity will take, and to help focus students on the aspects that you want them to learn.

Lab Notebook

As part of the virtual experience, students answer questions in a virtual lab notebook that opens in another window. However, if the virtual lab will take more than one class session to complete, know that the answers they type are NOT saved from one login to the next. Therefore, for your convenience, a pdf of the lab notebook questions are available for you to copy and give to students so that they may have a more permanent version of the answers they write in their lab notebook. Additionally, on the student entry page, students will be given the option of downloading a Word doc of the lab notebook, so that they can type their notes there, and save it for later use.

Virtual Neuroscience Lab Lab Book

CCSI Connecticut College Science Institute

Virtual Neuroscience Lab

Lab Book

Name: _____

Instructions: This is your lab book. The lab itself is open in another window. As you go about the lab completing tasks, you will need to answer specific questions and to record your observations. Do so in the text fields you see below. You can expand any text field by dragging the bottom right corner downward. Use this lab book as a reference when the time comes to publish the results of this experiment.

Desk area

1. What are the two phases of motivated behavior?

2. What is known about the effects of cocaine on dopamine levels in the brain?

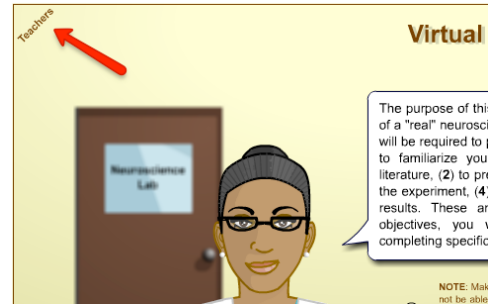
3. What is the hypothesis being tested in this experiment?

4. If the hypothesis is true, then what should you observe?

Answers to the student lab notebook questions are available in the professional development manual available for teachers to download.

Two Versions of the Virtual Cocaine Lab

There are two versions of this lab. The first is the Basic version in which you complete the virtual lab in one sitting. The second is the Flexible version that allows you to jump to various parts of the lab. This flexible version is a good choice for classes that plan on completing the lab over a series of class sessions. The launch page for both versions look similar, however, in the flexible version, the word “teachers” appears in the upper left hand corner. Once you scroll over this, the corner folds down to reveal a button that reads “go to teacher’s area.” The links available on this page allow you to jump to various parts of the lab without having to redo tasks from previous lab stations.



Implementation Tips for the Four Lab Areas

You can save class time if you have students read the textbook content before they come to class. Or if you prefer, have them watch the “Background on Dopamine and Cocaine” tutorial. Either way, as they learn about neurobiology they should also answer the first seven lab notebook questions.

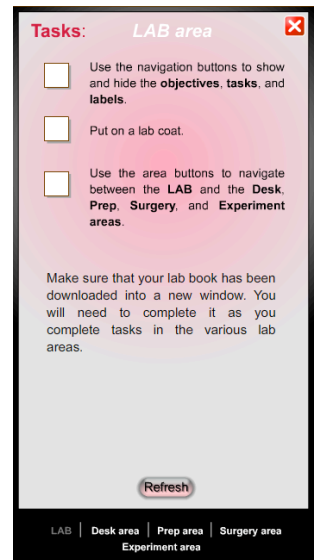
There is a special student entry to the Virtual Cocaine lab. On this page they will find the “Overview” tutorial that all students should watch before they begin the lab. You could assign this to be completed as homework or it could be viewed right before they enter the lab.

Once your students have entered to the lab, and oriented themselves to the buttons, they will proceed to the desk area.

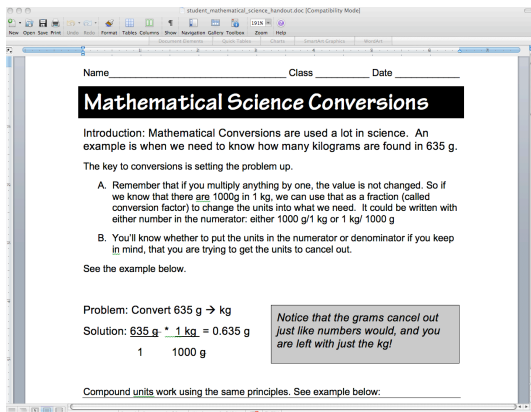
Desk Area

If your students read the paper copies of the three virtual books found in the desk area, or they watched the “Background on Neurobiology Content Tutorial” they will still need to open and close each book so that the tasks are checked off on their protocol check list. If tasks are not checked off, students are not allowed to proceed through the rest of the lab.

Preparation Area



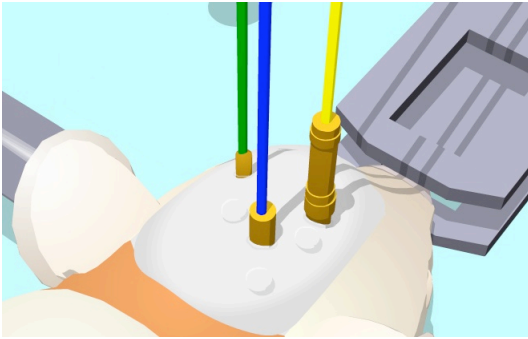
After the desk area, students proceed to the preparation area, where they will weight and anesthetize a rat.



Students will need to know how to calculate how much anesthesia to give the rat. If they have not learned about mathematical conversions, or need reminding, there is a worksheet you can use to help them practice. This worksheet can be found in the professional development manual on our website. Remind students to read the tasks so they know what to do at this station.

Surgery Area

Then students move to the surgery area.



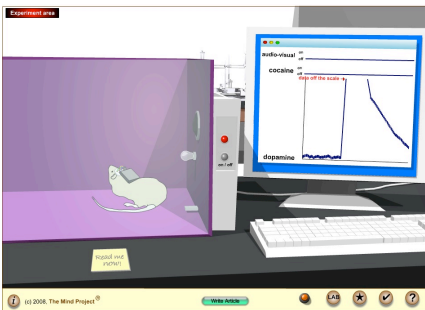
Depending on your own curricular goals, you may not require students to understand the details of the surgery. However, there are basic points that they must understand in order to complete the lab. These crucial points include:

A tube (cannula) is surgically implanted so that cocaine can be directly injected into the circulatory system. Various electrodes are being implanted into the brain, so that the levels of dopamine can be measured. All of this is completed on a rat that will recuperate and then be observed.

Experiment Area

The experiment area is the crux of the virtual lab experience. Students will watch the rat's behavior as they monitor the dopamine levels in the rat's brain.

If students have been completing their lab notebook questions, and understand the purpose of the previous surgery, they should know that they are looking for large spikes in dopamine levels at times OTHER than 30 seconds after the rat presses the lever – which is the point at which the cocaine actually hits the brain.



Because reading graphs is critical to understanding the data collected in this virtual experiment, you may want to review these skills with students before they begin the lab. An orientation to reading the graph in this experiment is also thoroughly explained in the "Overview" tutorial.

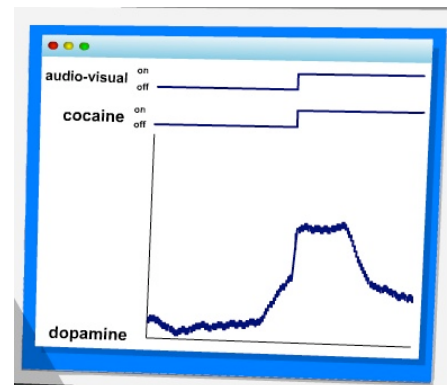
This graph spike [shown in the left figure] is the one that occurs 30 seconds after the rat presses the bar. Notice that it goes off the graph. The spike students are looking for, looks like this [shown in the figure below] and occurs right before the rat presses the bar.

Article Writing Area

After completing the experiment students will be asked to answer 14 quiz questions.

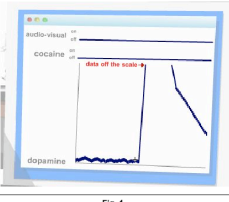
The virtual lab was designed so that students could use the notes they wrote in their lab notebooks to help them answer these questions. There is a pdf file of the quiz answer sheet available for teachers to download.

The answers to these questions are used to "publish" a journal article. This offers an excellent review of what the student learned . . . or should have learned. For many students, they don't fully "put all the pieces together" until they read the article carefully. Then they



Article writing area

Now we must present our data, analysis, and conclusion. Take a look at Figure 1 below. There was a very rapid and substantial dopamine increase approximately 36 seconds after the rat pressed the bar and 30 seconds after cocaine was administered. Dopamine levels returned to normal approximately 10 seconds later after a rapid then gradual decrease.



Given what is known about the effects of cocaine on the brain, which of the following is false?

- It took approximately 30 seconds for the cocaine to reach the brain.
- This dopamine increase is consistent with other studies where it was shown that dopamine levels increase rapidly and substantially when cocaine is consumed.
- This dopamine increase was caused by cocaine being consumed.
- This dopamine increase was caused by the cocaine reward being anticipated.
- Cocaine causes an increase in dopamine because cocaine blocks dopamine transporters.

Next Question Yes, that is correct.

Fig. 1

© 2008, The Mind Project®

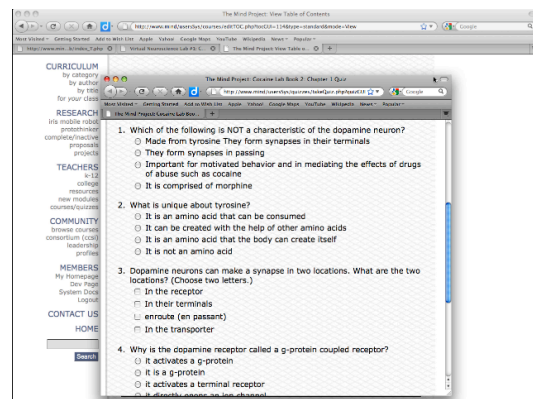
say “Wow, that really is cool. I really did do all of that, and it all makes sense.” This is a good time to discuss with students that this really is how science is done. Scientists conduct experiments and then share their results in journal publications.

Assessment Ideas

Your curricular goals will determine how you assess the student’s experience during the Virtual Cocaine Lab. If your goal was to include an enrichment activity that is connected to content you recently covered, or will cover, then a completion grade may be all that you need.

However, if you want a bit more accountability for students, have them turn a paper copy of their completed lab notebook. If you want to make sure they completed the quiz at the end, have them show proof of the final article. Then you will know that they got all the quiz questions correct.

In addition to the quiz at the end of this laboratory, The Mind Project also provides a quiz question repository, where you can either pick prewritten quizzes or individually pick questions you want to put into a quiz. Students can take these quizzes online at our website and the server will grade them for you. To use this function, all you have to do is have Mind Project accounts for you and your students.



The Mind Project: View Table of Contents

1. Which of the following is NOT a characteristic of the dopamine neuron?

- Made from tyrosine. They form synapses in their terminals.
- They form synapses in passing.
- Important for motivated behavior and in mediating the effects of drugs of abuse such as cocaine.
- It is comprised of morphine.

2. What is unique about tyrosine?

- It is an amino acid that can be consumed.
- It can be created with the help of other amino acids.
- It is an amino acid that the body can create itself.
- It is not an amino acid.

3. Dopamine neurons can make a synapse in two locations. What are the two locations? (Choose two letters.)

- In the receptor
- In their terminals
- enroute (en passant)
- In the transporter

4. Why is the dopamine receptor called a G-protein coupled receptor?

- It activates a G-protein
- It is a G-protein
- It activates a terminal receptor
- It directly opens an ion channel

Pilot Testing Labs

We are always interested in knowing the teachers who decide to implement one of our labs. Please email us to let us know you are using it. mindsup@ilstu.edu We would be happy to support you in any way that we can.

You may also want to inquire if we are offering any pilot testing incentives. At times, we pay teachers to implement labs with students. This includes some pre/post testing surveys for both teacher who implements the lab and for the students who complete it.

Where to Go From Here?

If you’re still listening, chances are that you are asking yourself, “What do I do next?”

Well, if you haven’t already, on the homepage of the Mind Project website, create a user account to become a Mind Project member. Familiarize yourself with the tutorials associated with the Virtual Cocaine lab. Decide how the lab best fits into your current curriculum and how you could be implement it. Contact us and let us know who you are and how you are planning to use the lab – and we will let you

know if we have any new support materials to make your job easier. You may also inquire about other teachers who are using the lab and might want to collaborate. And last, implement the lab with students.

This Virtual Science Lab has been supported by NSF grant #0127561 and NIH/NCRR/SEPA grant #R25RR020425.

Thank you for watching this professional development tutorial for The Virtual Cocaine Lab made available from The Mind Project. I hope that you found it helpful in the decision of whether or not you may choose to use the lab with your students. Please feel free to contact us with any questions you may have. And don't forget to look at the other free virtual labs that we offer.

References:

National Research Council. (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. Available from: http://www.nap.edu/catalog.php?record_id=13165 (accessed Aug 2011).

National Research Council. (1996). *National Science Education Standards*. Center for Science, Mathematics, and Engineering Education. Washington, DC: The National Academies Press. Available from: http://www.nap.edu/catalog.php?record_id=4962 (accessed Aug 2011).

Illinois State Standards From: <http://www.isbe.state.il.us/ils/science/standards.htm> (accessed Aug 2011).