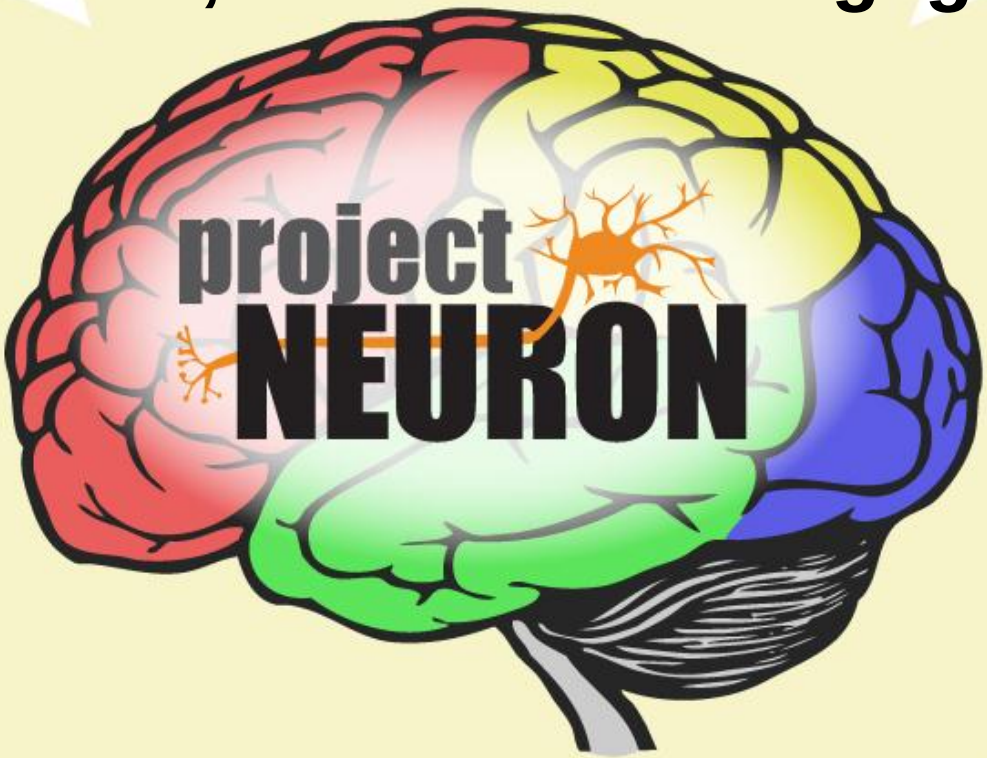
Using a Project-based Science Unit to Link Next Generation Science Standards, Common Core Standards, and Student Engagement



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What is Project NEURON?

- Curriculum development that brings engaging inquiry-based units to high school classrooms, using neuroscience research as a context
- Professional development

- Comprised of science educators, research scientists, neuroscience graduate students, education graduate students, and undergraduates

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Project NEURON Curriculum Units

All available at http://neuron.illinois.edu

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- Do you see what I see?
  - *Light, sight, and natural selection*
- What can I learn from worms?
  - *Regeneration, stem cells, and models*
- What makes me tick…tock?
  - *Circadian rhythms, genetics, and health*
- Why dread a bump on the head?
  - *The neuroscience of traumatic brain injury (TBI)*
- What changes our minds?
  - *Foods, drugs, and the brain*
  - *Toxicants, exposure, and the environment*

What changes our minds?

Foods, drugs, and the brain

- Lesson 1: What changes our minds?
- Lesson 2: How do we define what changes our minds?
- Lesson 3: How do drugs affect planarians?
- Lesson 4: How does an estrogen affect a rat's mind?

What changes our minds? *(cont.)*

- Lesson 5: What are the effects of drugs on the nervous system?
- Lesson 6: How do neurons communicate?
- Lesson 7: How do drugs affect neuron communication?
- Lesson 8: How can animal models reflect the effects of drugs?
- Lesson 9: When should the FDA regulate a drug?

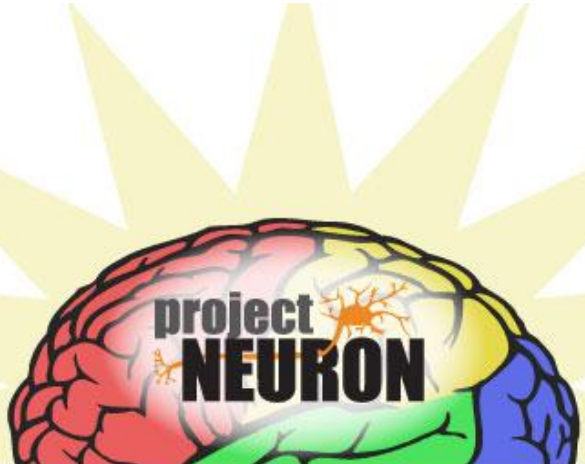
What changes our minds?

Foods, drugs, and the brain

- Lesson 1: What changes our minds?
- Lesson 2: How do we define what changes our minds?
- Lesson 3: How do drugs affect planarians?
- Lesson 4: How does an estrogen affect a rat's mind?

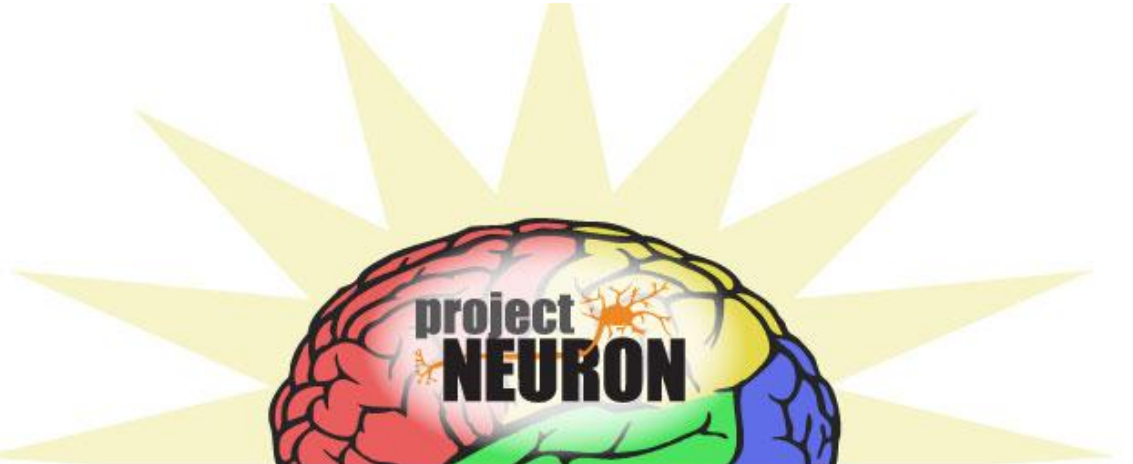
Goals

- Participate in hands-on preview of unit activities.
- Discuss how to use activities in your classroom and link them to standards.

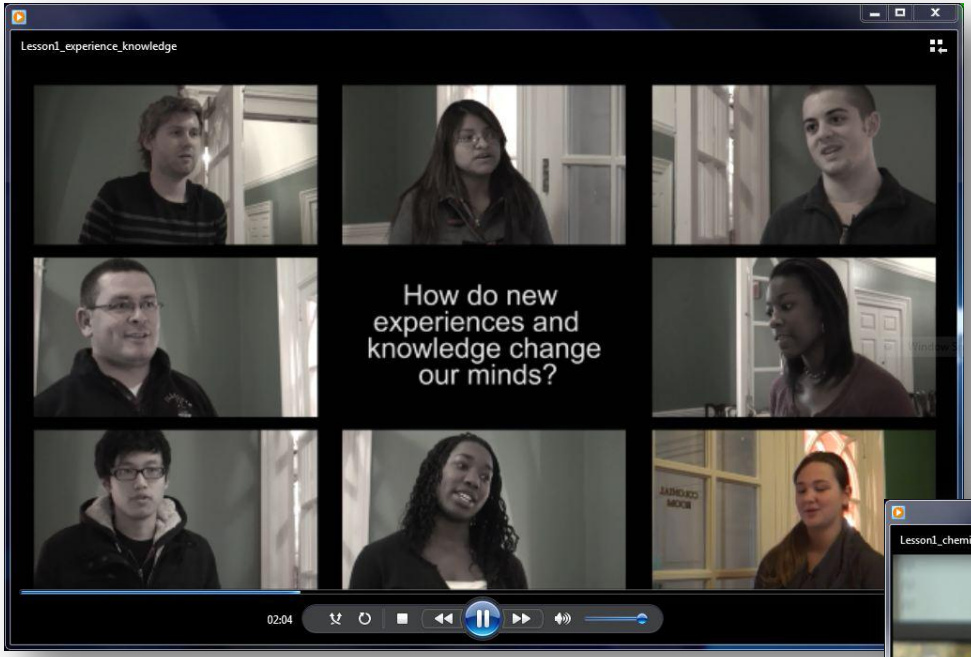


Lesson 1: What changes our minds?

- Brainstorm
- Video clip



What changes our minds?



What changes our minds?

Student Survey

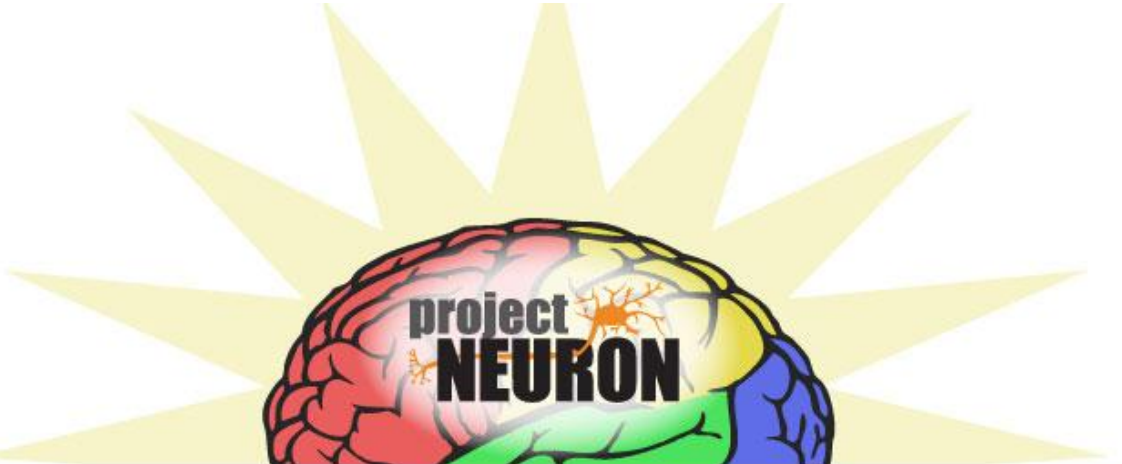
Directions: Answer the following questions as best as you can to get an accurate picture of the types of substances with which you come into contact.

Have you consumed any of the following in the past month? If you have, circle "yes" or "no". If you circle "yes", indicate the frequency of consumption (e.g. once a month, once a week, multiple times a day, etc.).

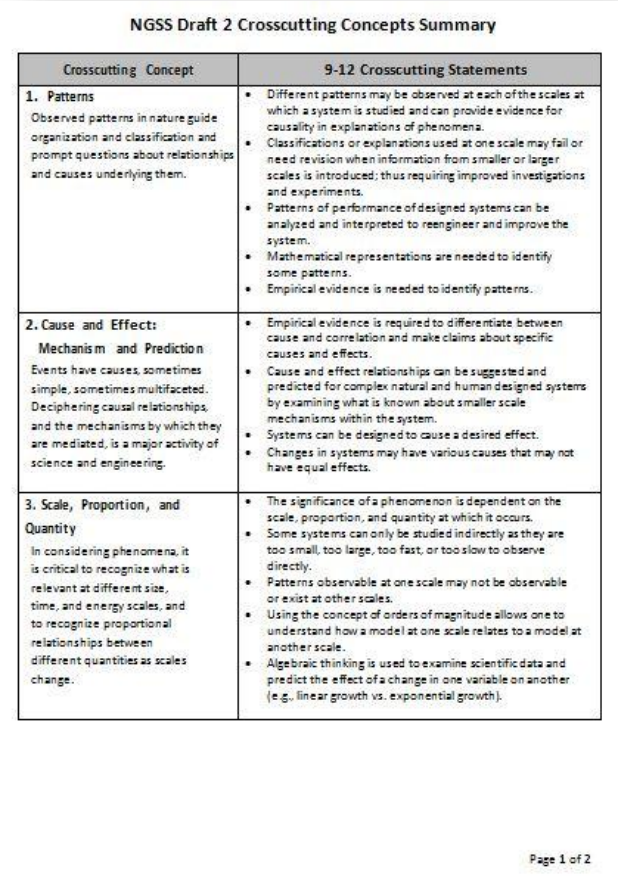
Item	Consumed? (circle yes or no)		Frequency
Coffee	Yes	No	
Tea	Yes	No	
Energy drinks	Yes	No	
Chocolate	Yes	No	
Regular soda	Yes	No	
Diet soda	Yes	No	
Sugar (as an additive to your food or drink)	Yes	No	

Discuss

- How would you use these activities?
- How do the activities relate to science and engineering practices and crosscutting concepts?



Linking to NGSS



NGSS Draft 2 Crosscutting Concepts Summary

Crosscutting Concept	9-12 Crosscutting Statements
1. Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.	• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. • Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. • Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. • Mathematical representations are needed to identify some patterns. • Empirical evidence is needed to identify patterns.
2. Cause and Effect: Mechanism and Prediction Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects.
3. Scale, Proportion, and Quantity In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.	• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. • Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. • Patterns observable at one scale may not be observable or exist at other scales. • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

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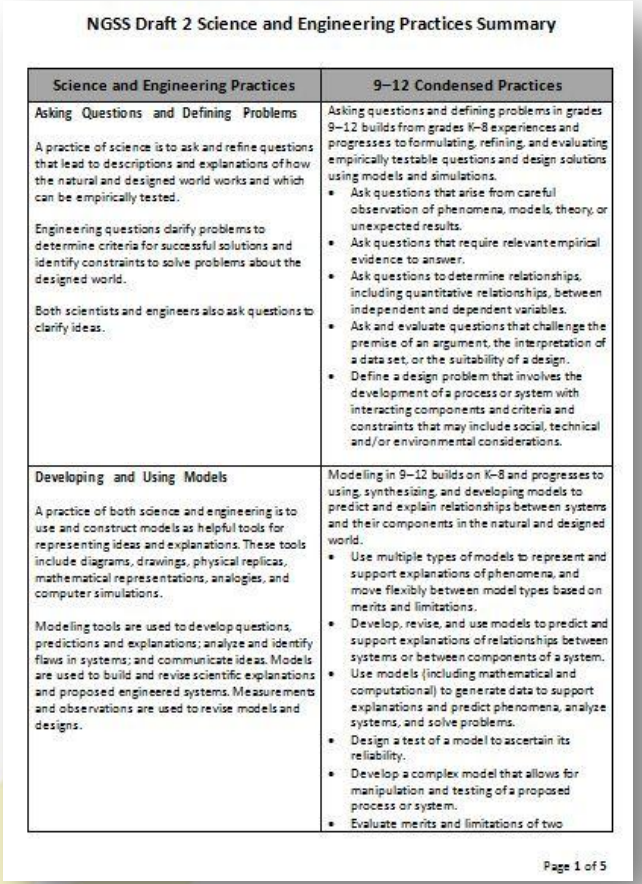

NGSS Draft 2 Science and Engineering Practices Summary

Science and Engineering Practices	9–12 Condensed Practices
Asking Questions and Defining Problems A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.	Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design solutions using models and simulations. • Ask questions that arise from careful observation of phenomena, models, theory, or unexpected results. • Ask questions that require relevant empirical evidence to answer. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. • Ask and evaluate questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design. • Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations.
Developing and Using Models A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.	Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and explain relationships between systems and their components in the natural and designed world. • Use multiple types of models to represent and support explanations of phenomena, and move flexibly between model types based on merits and limitations. • Develop, revise, and use models to predict and support explanations of relationships between systems or between components of a system. • Use models (including mathematical and computational) to generate data to support explanations and predict phenomena, analyze systems, and solve problems. • Design a test of a model to ascertain its reliability. • Develop a complex model that allows for manipulation and testing of a proposed process or system. • Evaluate merits and limitations of two

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2. The Next Generation Science Standards are student performance expectations – NOT curriculum.

Even though within each performance expectation Science and Engineering Practices (SEP) are partnered with a particular Disciplinary Core Idea (DCI) and Crosscutting Concept (CC) in the NGSS, these intersections do not predetermine how the three are linked in the curriculum, units, or lessons; they simply clarifies the expectations of what students will know and be able to do be the end of the grade or grade band. Additional work will be needed to create coherent instructional programs that help students achieve these standards.

Alignment to *A Framework for K-12 Science Education*

Unit:

		L1	L2	L3	L4	L5	L6
Science and Engineering Practices	Asking questions and defining problems						
	Developing and using models						
	Planning and Carrying Out Investigations						
	Analyzing and Interpreting Data						
	Using mathematics and computational thinking						
	Constructing explanations and designing solutions						
	Engaging in argument from evidence						
	Obtaining, evaluating, & communicating information						
Earth and Space	ESS1 Earth's Place in the Universe						
	ESS2 Earth's Systems						
	ESS3 Earth and Human Activity						

5-PS4 Waves and Their Applications in Technologies for Information Transfer

5-PS4 Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

5-PS4-a. Apply scientific knowledge of how lenses bend light to design a tool to enhance vision.* [Clarification Statement: Examples of tools that use lenses include telescopes, binoculars, microscopes, and eyeglasses.] [Assessment Boundary: Quantitative details of refraction not to be included.]

5-PS4-b. Communicate information of how technology has improved over time to increase our ability to see objects and make scientific discoveries about the universe.* [Assessment Boundary: Students should be able to interpret information that is provided to them rather than memorizing specific examples.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing	**PS4.B: Electromagnetic Radiation** ▪ A great deal of light travels through space to Earth from the sun and from distant stars. Because lenses bend	***Connections to Engineering, Technology,***

Connections to other topics in this grade-level: will be added in future version.

Articulation across grade-levels: will be added in future version.

Common Core State Standards Connections:

ELA/Literacy –

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS4-c)
RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. (HS-LS4-f)
RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-LS4-b),(HS-LS4-c)
RST.9-10.8	Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS4-e),(HS-LS4-a)
RI.9-10.8	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning. (HS-LS4-e), (HS-LS4-a)
WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-LS4-d), (HS-LS4-e), (HS-LS4-a)*
WHST.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *(HS-LS4-d), (HS-LS4-e), (HS-LS4-a)*
WHST.9-10.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS4-f)
WHST.9-10.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. *(HS-LS4-e), (HS-LS4-a)*
WHST.9-10.9	Draw evidence from informational texts to support analysis, reflection, and research. *(HS-LS4-d), (HS-LS4-e), (HS-LS4-a)*
SL.9-10.2	Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source. (HS-LS4-d),(HS-LS4-e),(HS-LS4-a)

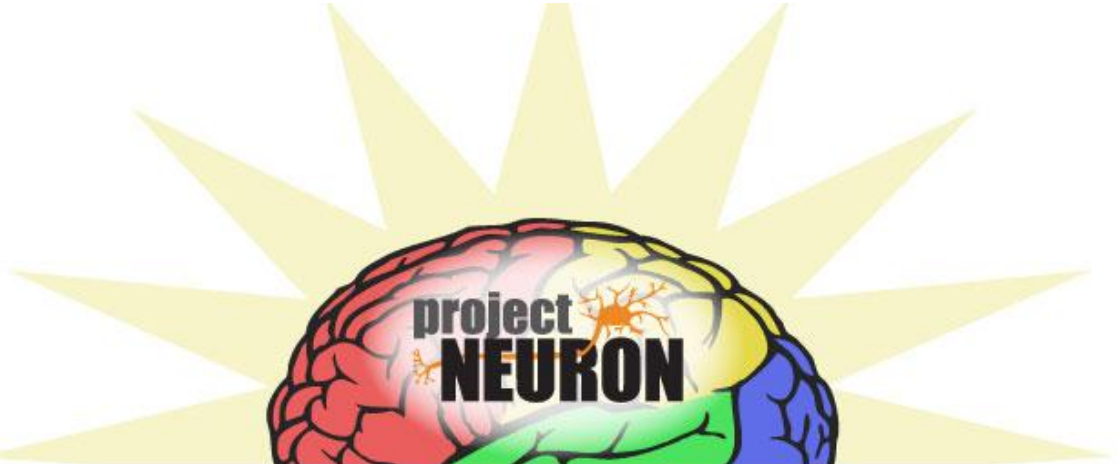
the text. (5-PS4-a),(5-PS4-b)

RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS4-b)
RI.5.8	Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). (5-PS4-a),(5-PS4-b)
RI.5.10	By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (5-PS4-a)
W.5.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (5-PS4-b)
W.5.7	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS4-b)
SL.5.4	Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. (5-PS4-b)

Mathematics –

Lesson 2: How do we define what changes our minds?

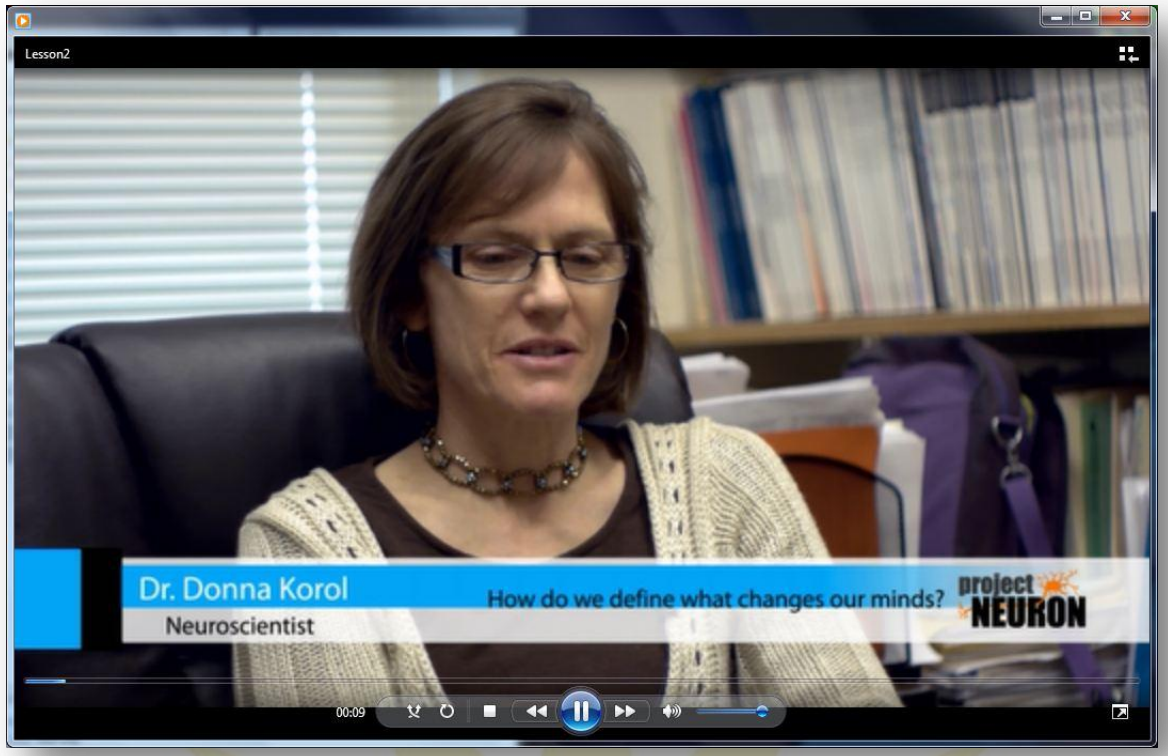
- Card sorting activity



How do we define what changes our minds?

Drug	Toxicant
Toxin	Poison

How do we define what changes our minds?



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How do we define what changes our minds?

Defini
Student Reading

How do we define a drug?

Drug is a common word used in society to
alterations to the body or mind. However, depend
affiliation, the term "drug" can mean many differ
approves the use of drugs for the medical field, u

A. Articles recognized in the official United S
Pharmacopoeia of the United States, or o
them
B. Articles intended for use in the diagnosis,
in man or other animals
C. Articles (other than food) intended to affe
other animals
D. Articles intended for use as a component

Physicians, pharmacologists, and veterina
while psychiatrists, psychologists, and others in th
but also include a subcategory of substances that
of the brain resulting in alterations in psychologic
drugs as chemicals that have the ability to becom

Two major classes of drugs are termed m
include synthetic or natural prescriptions, over th
acids, hormones, anesthetics, and vitamins. Psych
variety of mental disorders from depression, schi

A final class of drugs involves those that a
and/or can lead one to psychologically addiction.
drugs in addition to everyday chemicals (such as a
addiction are characterized by repeated use, rega
and other relationships while not necessarily caus

1. What are some drugs that would fall under the
deem as a "drug"? How do these differ?

2. Can a drug used to treat a medical condition be
how this could happen?

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include synthetic or natural prescriptions, over the counter (OTC) drugs, antivirals, vaccines, antibodies, acids, hormones, anesthetics, and vitamins. Psychotropic drugs are used to treat the symptoms of a variety of mental disorders from depression, schizophrenia, bipolar disorder, and ADHD.

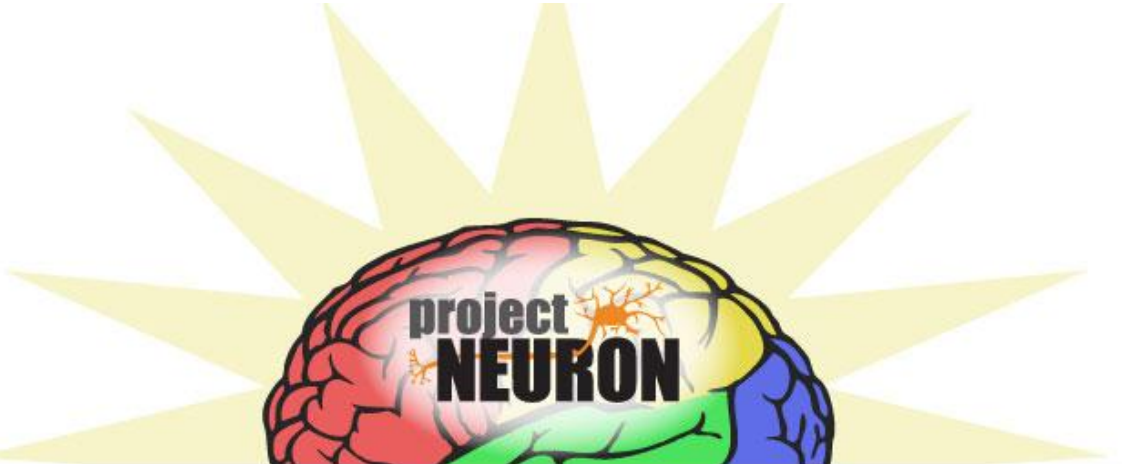
A final class of drugs involves those that are abused, substances that are harmful to the body and/or can lead one to psychologically addiction. These substances can be any of the aforementioned drugs in addition to everyday chemicals (such as aerosols, solvents, glues) or illicit drugs. Drugs of addiction are characterized by repeated use, regardless of the damage done to health, family, career, and other relationships while not necessarily causing a physical or psychological addiction.

1. What are some drugs that would fall under the FDA's definition of "drug"? What would a psychologist deem as a "drug"? How do these differ?

2. Can a drug used to treat a medical condition become a drug of abuse? Can you give an example of how this could happen?

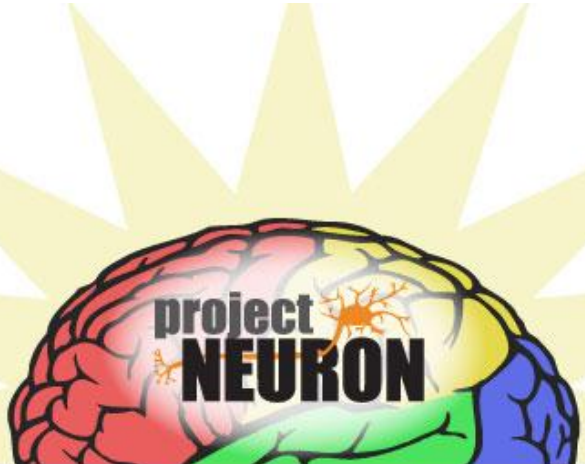
Discuss

- How would you use these activities?
- How do the activities relate to science and engineering practices and crosscutting concepts?



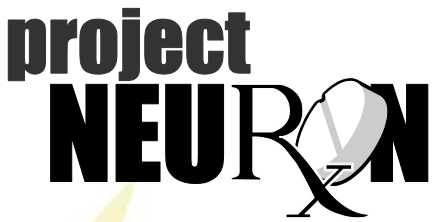
Goals Revisited

- Participate in hands-on preview of unit activities.
- Discuss how to use activities in your classroom and link them to standards.



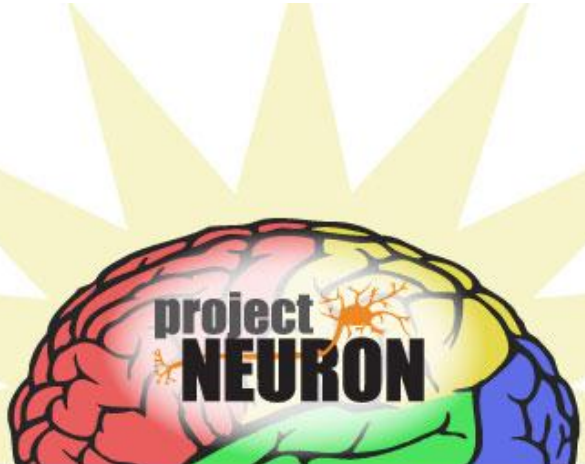
Unit Focus

- What changes our minds?
  - Foods, drugs, and the brain
  - Toxicants, exposure, and the environment



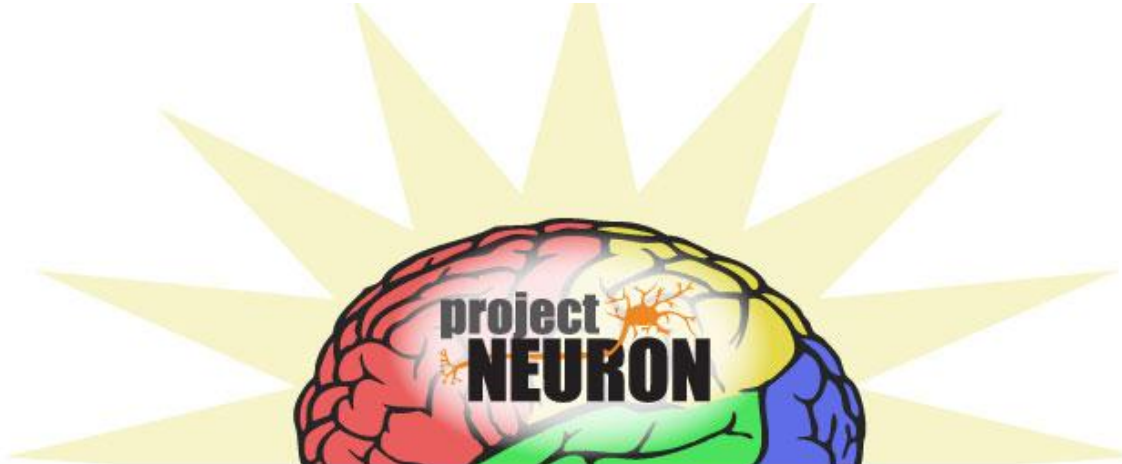
Project NEURON Web Site

http://neuron.illinois.edu



Summer Professional Development

- More information on web site



Acknowledgements

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- University of Illinois

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Session Evaluation

- Please complete the session survey available online.
- Session title: Using a Project-based Science Unit to Link Next Generation Science Standards, Common Core Standards, and Student Engagement