Use of Animals for Medical Testing

science take·out
just add students™

A team of scientists has developed a new medicine called **NicoBlock**. They hope that NicoBlock will be safe and effective for use as a smoking cessation medication. It is designed to interfere with the brain pleasure mechanisms that lead smokers to crave nicotine and continue smoking.

Introduction: NicoBlock, a Smoking Cessation Medicine

1. Read the paragraphs below. For each paragraph, write the letter of the diagram from the diagram sheet entitled **Effects of Nicotine and NicoBlock** that best illustrates the information.

_____ When someone smokes tobacco, nicotine is inhaled and travels through the bloodstream from the lungs to the brain. Nicotine then attaches to the nicotine **receptors** in the brain and triggers brain cells to release a **neurotransmitter** (chemical messenger) called dopamine. The release of dopamine in the brain results in a feeling of pleasure.

_____ The effect of nicotine only lasts for a short time. When someone quits smoking, there is no nicotine to trigger the release of dopamine needed for a feeling of pleasure.

_____ **NicoBlock** is designed to interfere with the brain mechanisms that cause smokers to crave nicotine and continue smoking. NicoBlock attaches to nicotine receptors and triggers the production of small amounts of dopamine, a neurotransmitter that leads to a pleasure sensation.

_____ Once **NicoBlock** attaches to the nicotine receptors, it remains in and blocks the receptors. Because the nicotine receptors are blocked by NicoBlock the brain cell receptors cannot bind to nicotine any more. Therefore, if someone smokes while using NicoBlock, nicotine cannot trigger the release of dopamine.

Before any new medication can be tested with humans, scientists need to conduct preliminary tests on animals to demonstrate that the medication is likely to be safe and effective for human use. For animal testing, researchers need to select animal species that are likely to react to **NicoBlock** in a way that is similar to humans.

Your Task:

You will work as a researcher to gather structural evidences and molecular evidences to determine which type of mammal (mice, cats, or baboons) is most likely to react to **NicoBlock** in a way that is similar to humans.




Mammals are warm-blooded vertebrates that:

- nourish their young with milk secreted by mammary glands
- have most or all of the skin usually covered with hair

Humans are mammals.

To make recording data for this lab activity easier, tear off the data table on the last page of these instructions. Record your data from the following tests on this data table.

Data Table: Comparison of Mammalian Species (Humans, Mice, Cats, and Baboons)

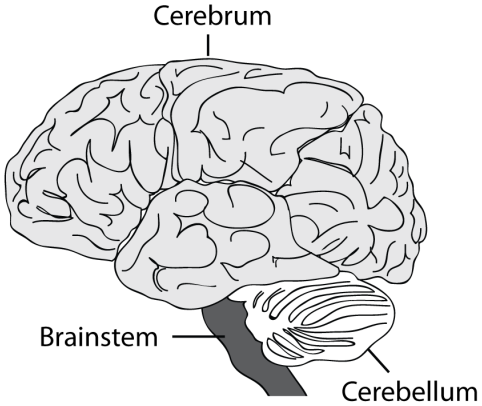
Species	Structural Evidences		Molecular Evidences			
	Test 1 Whole Brain (structures present and relative size)	Test 2 Brain Section Folds (many, few, none)	Test 3 Nicotine Receptors (present or absent)	Test 4 Nicotine Detoxifying Enzymes (present or absent)	Test 5 Proteins in Brain Fluid (locations of bands)	Test 6 Differences in DNA base sequence for DATP gene
Human 	Cerebellum Brainstem Large cerebrum	Many	Present	Present	Bands at 1, 3, 4, and 6	
Mouse 						
Cat 						
Baboon 						

Part 1: Structural Evidences—Comparing the Parts of the Brain

Test 1 – Structural Characteristics of Whole Brains

Specimens of whole brains for humans and the three species (mouse, cat and baboon) were photographed from various angles. Use the **Whole Brains** photographs in your kit to complete the following:

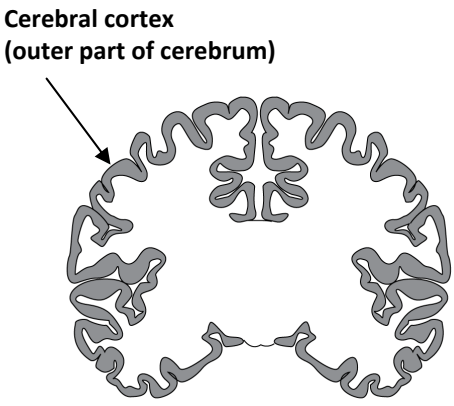
1. Compare the structures of the whole brain from a human with the whole brains from a mouse, a cat, and a baboon. Use the diagram on the right as a guide when making your comparisons. Consider the presence or absence of different brain sections and their relative sizes.
   - **Cerebrum**—Controls conscious sensation, voluntary movement, memory, and decision-making
   - **Cerebellum**—Controls balance and posture
   - **Brainstem**—Controls breathing and heart rate



2. Record your observations of the structures on the **Data Table: Comparison of Mammalian Species (Humans, Mice, Cats and Baboons)**.

Test 2 – Structural Characteristics of Stained Brain Sections

The folds or indentations on the cerebral cortex (outer part of the cerebrum) increase the surface area for interactions between neurons. Midcoronal brain sections were prepared by cutting and then staining thin slices from the same regions of the brains. Use the **Midcoronal Brain Sections** photographs in your kit to complete the following:



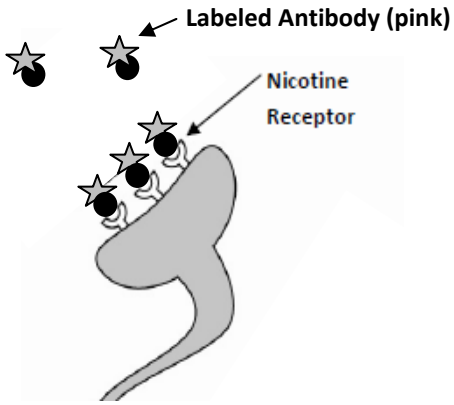
1. Compare the <u>number of folds</u> (many, few, or none) in the human cerebral cortex the number of folds in the cerebral cortex of the mouse, cat, and baboon.

2. Record your observations of the number of folds on the Data Table.

Part 2: Molecular Evidences—Comparing the Molecules in the Brain

Test 3 – Observation of Antibodies Attached to Nicotine Receptors

Human brain neurons have nicotine receptors. Antibody tests can be done to determine whether the brain neurons of mice, cats, and baboons have nicotine receptors on their surfaces. If nicotine receptors are present on neurons, the pink labeled antibodies will attach to the receptors and produce pink spots.



1. Observe the photos that show brain tissues treated with labeled antibodies. The brain tissues will have pink spots to indicate where the antibodies attach to nicotine receptors.

2. Record your observations (nicotine receptor present or not present) on the Data Table.

Test 4 –Testing for Nicotine Detoxification Enzymes

Nicotine is a toxin (poison). The human liver contains enzymes that detoxify (break down) nicotine so that it can be excreted with urine. You will test mice, cats, and baboons to see which species also contain enzymes that detoxify nicotine.

1. Obtain tubes of liver enzymes from humans, mice, cats, and baboons.

2. Use the matching labeled pipettes to place 3 drops of liver enzymes from humans, mice, cats, and baboons on the appropriate circles on the Liver Enzyme Test Sheet.

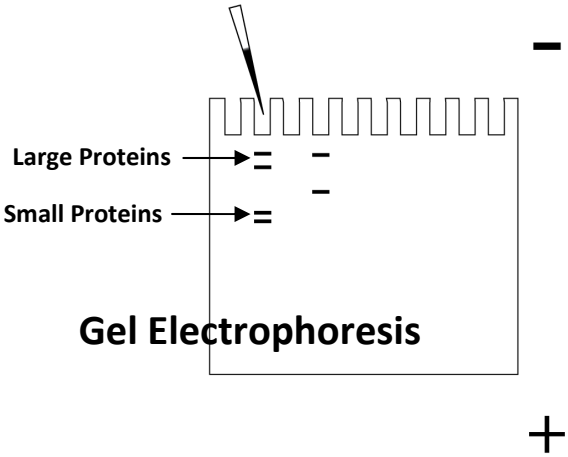
3. Use the small wooden scoop to add 1 tiny scoop of powdered nicotine to each of the circles. If the enzyme is present, a fizzing reaction will happen. *Note: This is simulated (not real) nicotine.*

4. Compare the liver enzyme activity in the human liver enzymes and in the liver enzymes from mice, cats, and baboons.

5. Record your observations of the enzyme activity on the data table.

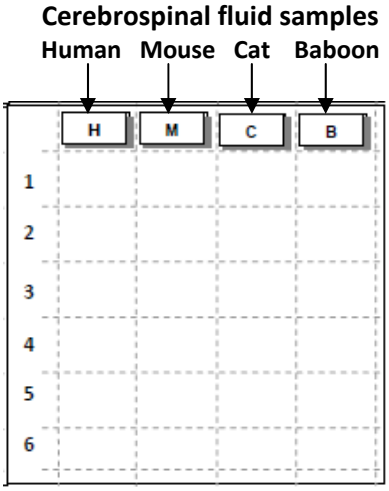
Test 5 – Comparing Proteins in Brain Fluid

Cerebrospinal fluid (the fluid that bathes the brain) contains a many different kinds of proteins. Scientists placed small amounts of cerebrospinal fluid from humans, mice, cats, and baboons into the wells of a gel.



The scientists used **gel electrophoresis** to separate the proteins based on their size. The gel was placed in an electrical field of an electrophoresis chamber. The electrical field caused the proteins in the cerebrospinal fluid samples to move different distances on the gel. **Small proteins move further than large proteins.**

The proteins in the gel are colorless. To see the proteins, you will need to add a stain to the gel. The stain will turn the proteins a bright pink color.



1. Place the protein electrophoresis gel (**simulated with a paper "gel"** that looks like the one in the diagram on the right) into the white tray.

2. Prepare the protein stain by measuring 10 ml of water in the small cup. Add the entire tube of protein stain to the water in the cup. Stir thoroughly with the stirrer.

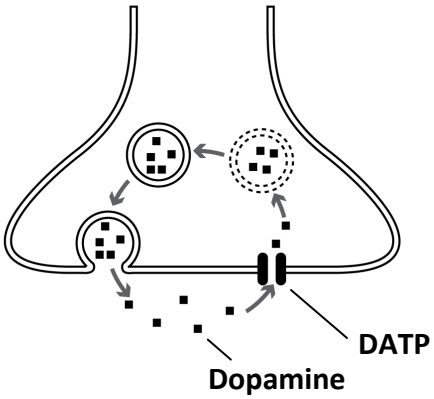
3. Pour all of the protein stain solution onto the white tray that contains the gel. Make sure the liquid completely covers the gel.

4. Compare the <u>locations</u> of the pink bands on the gel (indicated by the numbers 1–6 on the side of the gel) for humans, mice, cats, and baboons.

5. Record your observations of the protein bands on the data table.

Test 6 – Comparing the DNA (Gene) Code for Dopamine Active Transport Protein

Once dopamine triggers a sensation of pleasure, special proteins on the surface of nerve cells, called Dopamine Active Transport Proteins (DATP), begin active transport of dopamine back into the nerve cells so that it can be stored for reuse. The **DATP gene** carries coded information that is used by neurons to make dopamine active transport proteins.



1. The sequence of DNA bases shown on blue "DATP Gene" sheet represent small parts of the DATP gene from a human. The letters represent DNA bases in the DATP gene.

Dopamine Active Transport Protein (DATP) Genes																																
Human	A	T	T	C	C	G	G	A	T	C	G	A	T	C	G	C	C	G	G	A	T	A	T	A	C	T	C	C	G	G	T	A	A	T	A	T	C
Mouse	A	T	T	C	C	G	G	A	T	C	G	A	T	C	G	A	C	G	G	A	T	A	T	A	C	T	C	C	G	G	T	A	T	T	A	T	C
Cat	A	T	T	C	C	G	G	A	T	C	G	A	T	C	G	C	C	C	G	A	T	A	T	A	C	T	C	C	T	G	T	A	A	T	A	T	C
Baboon	A	T	T	C	C	G	G	A	T	C	G	A	T	C	G	C	C	G	G	A	T	A	T	T	C	T	C	C	G	G	T	A	A	T	A	T	C

2. Circle the DNA bases on the mouse (pink), cat (green), and baboon (yellow) gene sequences (order of A, T, G, and C's) that are <u>different</u> from the human base sequence.

3. Count and record the <u>number of differences</u> in the DNA base sequences on the data table.

Part 3: Analysis of Results

1. Using all of the structural and molecular evidences in your data table, which mammal (mouse, cat, or baboon) would you select for animal testing to determine whether **NicoBlock** would be safe and effective for use by humans? _____

2. Explain your choice by citing four specific evidences from the data that you recorded on the data table.
   - _____
   - _____
   - _____
   - _____

3. Which kind of evidence – structural or molecular – is most important when making decisions about the selection of animals for use in animal testing? Explain why.

   _____

   _____

4. List four characteristics (structural or molecular) which humans, mice, cats, and baboons all have in common.
   - _____
   - _____
   - _____
   - _____

5. Explain how the data you collected provides evidence that humans, mice, cats, and baboons evolved from a common ancestor.

   _____

   _____

6. Do you think it would be possible to use the other two mammals for testing **NicoBlock**? Explain why or why not.

   _____

   _____

Part 4: Costs for Research Animals

Obtaining and caring for animals used for medical testing can be expensive! Scientists need to weigh the **benefits** of using species that are most similar to humans with the **costs** involved for purchasing and caring for research animals.

Scientists are also aware that their experiments will be more **reliable** if they use a large number of research animals.

	Mouse 	**Cat** 	**Baboon** 
Cost to purchase one animal	$5.00	$50.00	$500.00
Cost to maintain one animal for one year including cages, food, and veterinary care.	$45.00	$200.00	$500.00
Total cost for purchase and care for one animal/year			
Number of animals that could be used if the researcher had a $10,000 budget for animals used in animal testing			

1. Complete the last two rows on the chart above. Show your work (how you arrived at the answer).

2. Which species would you select for the **NicoBlock** testing if you were concerned about the cost of testing and the reliability of testing? Explain your answer using information from your data table and the information in the chart above.

   _____

   _____

Part 5: Ethical Issues

1. Read the information below. As you read, underline the statements that support the use of animal testing in one color. Use a different color to underline the statements that oppose the use of animal testing.

Use of Animals for Medical Testing?

The use of animals for medical testing is a controversial subject, with a great deal of passion, emotion and ideas on both sides regarding the ethics of this practice. Some people support all types of animal testing. Other people oppose all types of animal testing. Other people support animal testing only under some circumstances while they oppose its use for other circumstances.

Generally, the scientific community is strongly in favor of animal testing. The medical breakthroughs that have occurred as a result of animal testing are considered the main reason to continue the practice, with the aim of reducing human suffering and saving human lives. Ultimately, supporters believe that the end result of saved human lives justifies the use animal testing.

There are a number of arguments against animal testing. Unlike human test subjects, animals cannot consent to the tests. Animal testing may expose animals to pain, suffering and potential deadly circumstances. While researchers work to minimize these risks, they may not be completely prevented.

There is no clear right or wrong answer to the controversy of animal testing that seems to please everyone. But, as a result of controversy about animal testing, regulations and laws have been established to require proper animal care in animal testing facilities. This is a positive step for both animal testing supporters and those who argue against it.

2. State two reasons for supporting animal testing.
   - _____
   - _____

3. State two reasons for opposing animal testing.
   - _____
   - _____

4. State one action that has been taken to reduce people's concern about the use of animals for drug testing.

_____

_____

5. Before the United States Food and Drug Administration (FDA) approves a drug for use by humans, it must be tested first on rodents (such as mice or rats) and then on non-rodents (such as cats, monkeys, baboons, or chimpanzees). Why do you think the FDA requires tests on non-rodents?

_____

_____

Data Table: Comparison of Mammalian Species (Humans, Mice, Cats, and Baboons)

Species	Structural Evidences		Molecular Evidences			
	Test 1 **Whole Brain** **(structures present and relative size)**	**Test 2** **Brain Section Folds** **(many, few, none)**	**Test 3** **Nicotine Receptors** **(present or absent)**	**Test 4** **Nicotine Detoxifying Enzymes** **(present or absent)**	**Test 5** **Proteins in Brain Fluid** **(locations of bands)**	**Test 6** **Differences in DNA base sequence for DATP gene**
Human 	**Cerebellum** **Brainstem** **Large cerebrum**	**Many**	**Present**	**Present**	**Bands at** **1, 3, 4, and 6**	
Mouse 						
Cat 						
Baboon