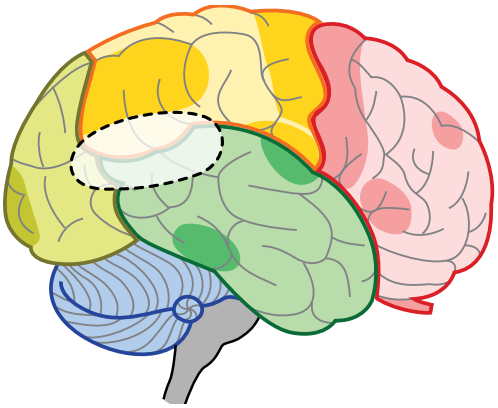

cutting out brain tumors

Ask A Biologist activity for classroom and home

By Eugene Chung

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About the Authors

Eugene Chung is an undergraduate majoring in Microbiology at Arizona State University. He is involved in research that is focused on novel treatments of neurological disorders.

Learn more

This is a companion PDF for this online article:

A Nervous Journey
askabiologist.asu.edu/explore/nervous-journey

Experiment Overview

Note: This activity deals with advanced, potentially sensitive topics. We advise it be reserved for students in middle school or higher grades. Teachers may want to check if students are open to the subject before starting the activity.

What is a brain tumor?

Your brain is made of billions of cells. These cells communicate with each other so you can see, hear, smell, taste, move, and even think. In very rare cases, cells change in bad ways and mutate. Mutations can make the cells grow uncontrollably so that they form a mass in the brain—a brain tumor. Brain tumors can cause many different symptoms depending on where they are in the brain. Some common symptoms include vomiting, weakness, seizures, headaches, and even changes in personality. They can also make it harder to walk, talk, see, and remember things.

How can we treat brain tumors?

Doctors can treat brain tumors many ways. One method is brain surgery. During surgery, a doctor opens the skull and physically cuts out the tumor from the brain. This is called surgical resection. The tumor can also be treated with a chemical mix called chemotherapy. Chemotherapy is toxic and can slow the growth of tumor cells, or kill them. A third option is radiation therapy. In this method, radiation energy is used to kill tumor cells. In many cases, a patient will receive all three treatments (surgery, chemotherapy, and radiation).

Surgery is often the main treatment used. Doctors who do brain surgery are called neurosurgeons and they go through many years of training. Physical removal of a tumor can be hard because tumor tissue can look similar to healthy brain tissue. Doctors want to remove as much of the tumor as possible. However, they have to be very careful because they do not want to hurt or remove any healthy brain.

How do doctors tell the difference between good and bad tissue? Before surgery, doctors will get detailed images of the brain by scanning the head with a CT or MRI machine. These images act like a map for doctors during surgery. Recent medical advances have also allowed doctors to label tumors with fluorescent tags that make the tumor "light up" during surgery. With the help of these fluorescent tags, doctors can visualize tumors. This makes it easier to find and cut out only the bad tissue. Try your hand at new tricks that brain surgeons use. See how much of the tumor you can cut out doing surgery when it is lit up with labels.

What you need

- Plastic brain mold
- Plastic tumor mold
- Unflavored gelatin
- Water
- Tonic Water
- Black Light
- Tools to remove brain tumor (e.g., plastic knife ("scalpel"), tweezers, spoon straws, etc.)

Before you begin

Before the surgery, review the different parts of the brain and what each part does. To do so, read through the articles What's in Your Brain? and What's Your Brain Doing? on Ask A Biologist.

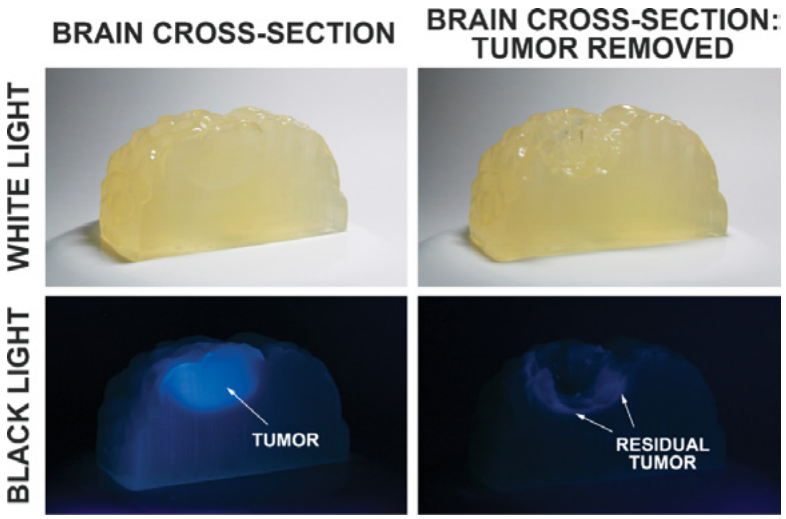
It is especially important for brain surgeons to know what different parts of the brain do. If a certain part of the brain is injured, a patient can lose their memory or lose certain functions.

In this activity, you will be trying both old and new techniques that doctors use to remove brain tumors. First, try removing a tumor that does not fluoresce. Next, with the help of a black light, try removing a tumor that lights up.

Experiment Overview *(continued)*

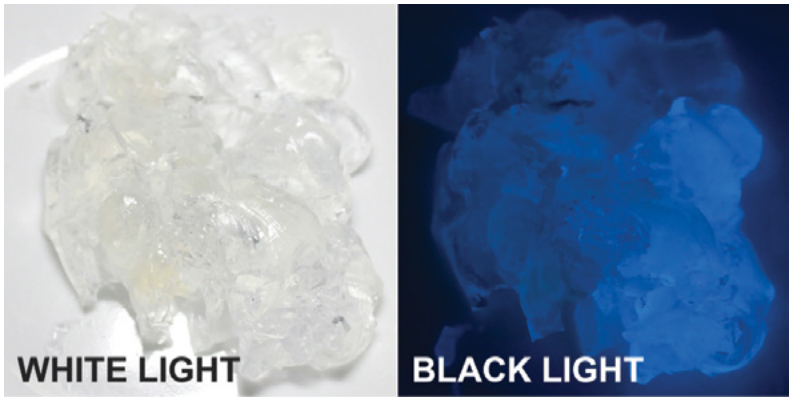
Procedure

1. Read the two stories about brain anatomy and brain function to prepare for the activity. Complete the What's in Your Brain? (PDF) and What's Your Brain Doing? (PDF) worksheets.
2. Get the two halves of your assigned brains (or two small whole brains). Read the patient description that comes with it. What types of symptoms does the patient have?
3. Before you begin your surgery, look at the first brain or brain half. Try to find the tumor. If you find it, what part(s) of the brain is it in?
4. After you have found the tumor, try to cut out as much of the tumor as you can. Try not to remove or injure anything that is not the tumor.
5. Now with your second brain or brain half, try removing the tumor with the help of the black light. The black light will make the tumor fluoresce.



Brain cross-section under white and black light.

6. After everyone has finished operating, compare the brains or brain halves. Shine the black light on the first brain (half) to see how much tumor you removed. Any remaining tumor will light up. Now look at the second brain (half). In which brain were you able to remove more of the tumor?



Resected tumor tissue (gelatin) under white and black light.

Extension: Something went wrong during surgery. Your patient has lost a function. You will be given a scenario describing the patient's symptoms. Try to figure out what part of the brain was injured during surgery.

Teaching Tips

Note: This activity deals with advanced, potentially sensitive topics. We advise it be reserved for students in middle school or higher grades. No matter the age of your students, you may want to check in with them to discuss the topic and make sure everyone is interested in completing the activity before you begin.

In this activity, students will be doing a basic simulation of brain surgery to remove a tumor. Physical removal of a brain tumor is called surgical resection. This is often the main method of treatment for brain tumors. It is important for doctors to be able to tell the difference between tumor and healthy tissue as completeness of tumor removal gives the patient a better chance of survival.

Recent advances in fluorescent labeling have allowed doctors to improve completeness of tumor removal. Fluorescent dyes absorb light of a particular wavelength and then emit or give off a light of longer wavelength. Fluorescence can be seen during surgery with special optical equipment. Additionally, these dyes can be engineered to accumulate and bind specifically to tumor tissue. Because the dyes are present specifically in the tumor tissue, only the tumor will fluoresce.

For this activity, the tumors will be made of tonic water which contains quinine. The quinine in the tumor absorbs UV light and emits a blue light that can be seen by the human eye. This makes it easier to identify what is tumor and what is healthy tissue. Students will try removing tumors both with and without the help of a black light. Although the tumor will be removed without a black light, the tumor will still contain quinine which will allow students to evaluate completeness of tumor removal after they are finished.

If prep time or funds are lacking, the activity can be modified by using smaller brain molds. Students can also work in groups or can take turns as a class identifying tissue that should be removed.

Overall, this activity provides a fun way to learn about brain anatomy and brain tumors. It can also excite students for a possible future in the medical field.

Tips for Classroom Implementation

Time required

Depending on how many brain molds are available to make multiple brains at the same time, it will take between two to eight hours prior to the activity to create all the brains. In class, the activity may take an additional one to two hours.

Estimated costs

- Plastic full brain mold: $5/mold
  amazon.com/Fun-World-Costumes-Gelatin-Standard/dp/B009S5SL90/ref=pd_sim_sbs_%20indust_1?ie=UTF8&refRID=0SRR8V7ZGRWF47HME2KQ
- Lower cost alternative: Small brain molds:
  $5.28 / 4 molds
  amazon.com/Cybrtrayd-M197-Chocolate-Copyrighted-Instructions/dp/B000EJRBHW/ref=sr_1_3?ie=UTF8&qid=1434493798&sr=8-3&keywords=brain+mold
- Gelatin: ~$2.25/brain (found at grocery stores but we recommend buying in bulk from amazon if using larger brains) **amazon.com/Knox-Unflavored-Gelatin-1-lb/dp/B001UOW7D8**

Teaching Tips *(continued)*

- Tonic Water: ~$2 (found at grocery stores)
- Black Light*: $5-$10/light
  amazon.com/Fortune-BL-A7-Portable-Black-Length/dp/B006T64ME4/ref=sr_1_sc_1?s=industrial&ie=UTF8&qid=1431472956&sr=1-1-spell&keywords=Fortune+BL-A7+Portable+Black+Ligh

*The black light used for this activity cannot be a torch/flashlight style light. These produce a light that is too focused/intense and will make the normal brain appear as if it is also fluorescing.

Classroom set-up

Have 2-4 students per group and supply each group with the two halves of a brain. The students should work together to remove the tumor. If time permits, have the groups present to the class at the end of the activity. Have them describe what symptoms their patient initially had, and show how much of the tumor they were able to remove. They should also present the parts of the brain the tumor touched.

In the extension activity, have the students also describe the post-operative scenario and explain what part of the brain they think was injured based off of the patient's symptoms.

Tips

- Turn off the lights when students are using the black lights in order to increase contrast between healthy and tumor tissue.

Objectives

1. Students will learn about the structures and functions of the brain as well as the biology of brain tumors.
2. Students will learn about real-world practices in the medical field.
3. Students will get to simulate some of the new techniques being used during brain surgery to improve outcomes.

Science Standards

Common Core Standards

- **CCSS.ELA-LITERACY.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.
- **CCSS.ELA-LITERACY.RST.9-10.9.** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Next Generation Science Standards

HS Structure and Function

- **HS-LS1-2.** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

How to Create the Brain

Recipe yields: 1 brain

Ingredients

- 1 brain mold
- 1 tumor mold
- 56 g of gelatin (8 packets)
- 7 cups water (3 cups hot, 4 cups cold)
- 2 cups tonic water (1 cup hot, 1 cup cold)
- Small amount of vegetable oil

Making the tumor

- Spray or smear the inside of the tumor mold with vegetable oil. Wipe away the excess.
- Slowly add 7 grams (1 packet) of gelatin to a cup of boiling tonic water while stirring to prevent clumping.
- Stir until gelatin is fully dissolved.
- Mix in one cup of cold tonic water (double check this is the tonic water).
- Pour into the tumor mold to fill it.
- Place the mold into the refrigerator until the gelatin is set.

*This amount should be enough for two or more tumors depending on the size of the tumor mold

Alternative steps for smaller brain molds (yields 4 small brains)

Slowly add 14 g (2 packets) of gelatin to 1 cup of boiling water in a separate bowl while stirring.

- Stir until gelatin is fully dissolved.
- Mix in 1 cups of cold water (NOT tonic water).
- Distribute the mixture evenly into the four brain molds, leaving some extra room for the tumor.

*We recommend using whole brains rather than half brains if using the smaller mold.

Making the brain

- Spray or smear the inside of the brain mold with vegetable oil. Wipe away the excess.
- Slowly add 49 g (7 packets) of gelatin to 3 cups of boiling water in a separate bowl while stirring.
- Stir until gelatin is fully dissolved.
- Mix in 4 cups of cold water (NOT tonic water).
- Pour the mix into the brain mold
- Allow the gelatin to partially set at room temp for 10-20 minutes
- Take the tumor out of the refrigerator and gently pull on the gelatin to release it from the sides of the mold. Invert the mold onto hand or plate.
- Place the tumor anywhere along the midline of the brain. This is also good if you cut the brain in half, so that tumor tissue will be in both halves. If you need to re-dissolve your gelatin brain a bit, dip the mold (without getting water in it) into a large bowl of hot water. It should loosen up a bit so you can insert the tumor.
- Place the brain in the fridge until the gelatin is set.
- To remove the brain, again gently pull on the gelatin to release it from the sides of the mold. Invert the mold onto a plate.
- Cut the brain in half length-wise with a large knife and store in the refrigerator until needed.

Patient Descriptions and Post Operative Scenarios

Patient: Michael Wu

Patient Description

Michael Wu is a 68-year-old male patient. He complained to his doctor about daily headaches. He also told his doctor that sometimes he has a hard time seeing things. Because of these symptoms, the doctor told him to see a special brain doctor called a neurologist. One week later, Michael was seen by the brain doctor. The doctor ordered a magnetic resonance imaging (MRI) scan of the patient's brain. The MRI showed a brain tumor. Michael has an appointment today to have the tumor removed. Remove as much as the tumor as you can. Be very careful. You do not want to remove or hurt any part of his normal brain.

Post-Operative Scenario

Good job! You were able to get most of the tumor out. Michael is recovering in his hospital room. He wakes up, but when you try talking to him, he says that he is having a hard time hearing what you are saying. Soon after, the patient's family comes into the room to see how he is doing. He seems confused. Michael does not seem to recognize the people in his room. A part of the patient's brain must have been hurt during the surgery. What part of the brain do you think was hurt? Based on the patient's symptoms, try to figure out which part of the brain was hurt so you can go back and fix it.

Answer: Temporal Lobe

Patient: Wallace West

Patient Description

Wallace West is a 55-year-old male patient. According to the family, the patient was at home when he began to have a seizure. The seizure lasted a minute and the family immediately called for emergency medical service. While they waited for an ambulance to come, he had more seizures. Each one lasted about a minute. After the seizures stopped, the patient complained of a headache and sore muscles. The family stated he seemed confused afterward. The patient stated he had never had seizures in the past. At the hospital, the patient was seen by a brain doctor called a neurologist. The patient had a computed tomography (CT) scan of his head. The CT scan showed a brain tumor. He is scheduled to have the tumor removed today. Remove as much as the tumor as you can. Be very careful. You do not want to remove or hurt any part of his normal brain.

Post-Operative Scenario

Good job! You were able to get most of the tumor out. Wallace is recovering in his hospital room. When the patient wakes up, he says he has a headache. You tell him a headache is common after surgery. A few hours later, the patient is given food from the cafeteria. The nurse notices that the patient is having difficulty getting the food in his mouth. Multiple times he misses his mouth and gets food on his cheeks. After finally taking a few bites, he complains that the food is really bland and tasteless. The nurse immediately notifies you. Something may have gone wrong. A part of the patient's brain must have been hurt during the surgery. What part of the brain do you think was hurt? Figure out which part of the brain was hurt so you can go back and fix it.

Answer: Parietal lobe

Patient Descriptions and Post Operative Scenarios *(continued)*

Patient: Erin Hughes

Patient Description

Erin Hughes is a 42-year-old female patient. She was seen in the emergency room after she fell at home. She said that walking has become harder recently. Her headaches have also been hurting more during the past few months. The emergency room doctor ordered a computed tomography (CT) scan because the patient said she hit her head when she fell. The CT scan showed a brain tumor. The patient then met with a neurosurgeon. She is scheduled to have the tumor removed today. Remove as much as the tumor as you can. Be very careful. You do not want to remove or hurt any part of her normal brain.

Post-Operative Scenario

Good job! You were able to get most of the tumor out. Erin is recovering in her hospital room. After the patient wakes up, she says that she has a dull headache but that it doesn't hurt too much. While she is recovering, she watches TV to pass the time. While watching her show, she begins to see two TVs. She is startled by the change in vision and calls for her nurse. When the nurse walks in, the patient sees two of nurses. The nurse immediately notifies you. Something may have gone wrong. A part of the patient's brain must have been hurt during the surgery. What part of the brain do you think was hurt? Figure out which part was hurt so you can go back and fix it.

Answer: Occipital Lobe

Patient: Deandre Jackson

Patient Description

Deandre Jackson is a 20-year-old male patient. He is currently in college and has been a straight A student. Recently however, the patient has been doing poorly on his tests. No matter how much he studies, he has a lot of trouble remembering what he learned. He says he has also had a lot of trouble concentrating. When he saw his normal doctor, the doctor could not find anything wrong. Because of his complaints, the patient was told to see a special brain doctor called a neurologist. After further evaluation, the patient had a computed tomography (CT) scan of his head. The CT scan showed a brain tumor. He scheduled an appointment to have the tumor removed today. Try removing as much of the tumor as you can. Be very careful. You do not want to remove or hurt any part of his normal brain.

Post-Operative Scenario

Good job! You were able to get most of the tumor out. Deandre is recovering in his hospital room. When he wakes up, he says that he feels okay except for a mild headache. He gets up to go to the bathroom. After taking a few steps, he begins to fall. He grabs on to the rail of his bed before falling. The patient tells the nurse that he is having trouble walking. When you check on Deandre, you notice that his steps are very jerky and unsteady. You think that something may have gone wrong. A part of the patient's brain must have been hurt during the surgery. What part of the brain do you think was hurt? Figure out which part was hurt so you can go back and fix it.

Answer: Cerebellum

Patient Descriptions and Post Operative Scenarios *(continued)*

Patient: Maria Cruz

Patient Description

Maria Cruz is a 57-year-old female patient. She is usually very happy and cheerful. For the past month however, her husband noticed that she had been feeling down all the time. She denied any increases in stress. She also denied any recent tragic events. The patient's husband also noticed that the patient seemed to be confused occasionally. The patient was seen by a doctor who was not able to find a cause for her depression. She was then referred to a special brain doctor called a neurologist. After further evaluation, the patient had a computed tomography (CT) scan of her head. The CT scan showed a brain tumor. She is scheduled to have the tumor removed today. Remove as much as the tumor as you can. Be very careful. You do not want to remove or hurt any part of her normal brain.

Post-Operative Scenario

Good job! You were able to get most of the tumor out. Maria is recovering in her hospital room. When she wakes up, she is happy to see that her family is in the room with her. She tries to sit up in bed but is unable to. She becomes startled and then tries to move her arms and wiggle her fingers. She is unable to. Her family immediately calls for you. Something may have gone wrong. A part of the patient's brain must have been hurt during the surgery. What part of the brain do you think was hurt? Figure out which part was hurt so you can go back and fix it.

Answer: Frontal Lobe

Patient: Jess Lowe

Patient Description

Jess Lowe is a 30-year-old female patient. The patient was seen in the emergency room after she vomited several times. She denied eating any unusual or spoiled food. All she ate that day was cereal and fruit for breakfast. She said that for the past couple of weeks, she has had dizzy spells where it felt like the room was spinning, making her nauseated. She said she hasn't been taking any new medications. The emergency room doctor thought the problem might be related to her brain. A brain doctor called a neurologist saw the patient and wanted a computed tomography (CT) scan of her head. The CT scan showed a brain tumor. She is scheduled for today to have the tumor removed. Try removing as much as the tumor as you can. Be very careful. You do not want to remove or hurt any part of her normal brain.

Post-Operative Scenario

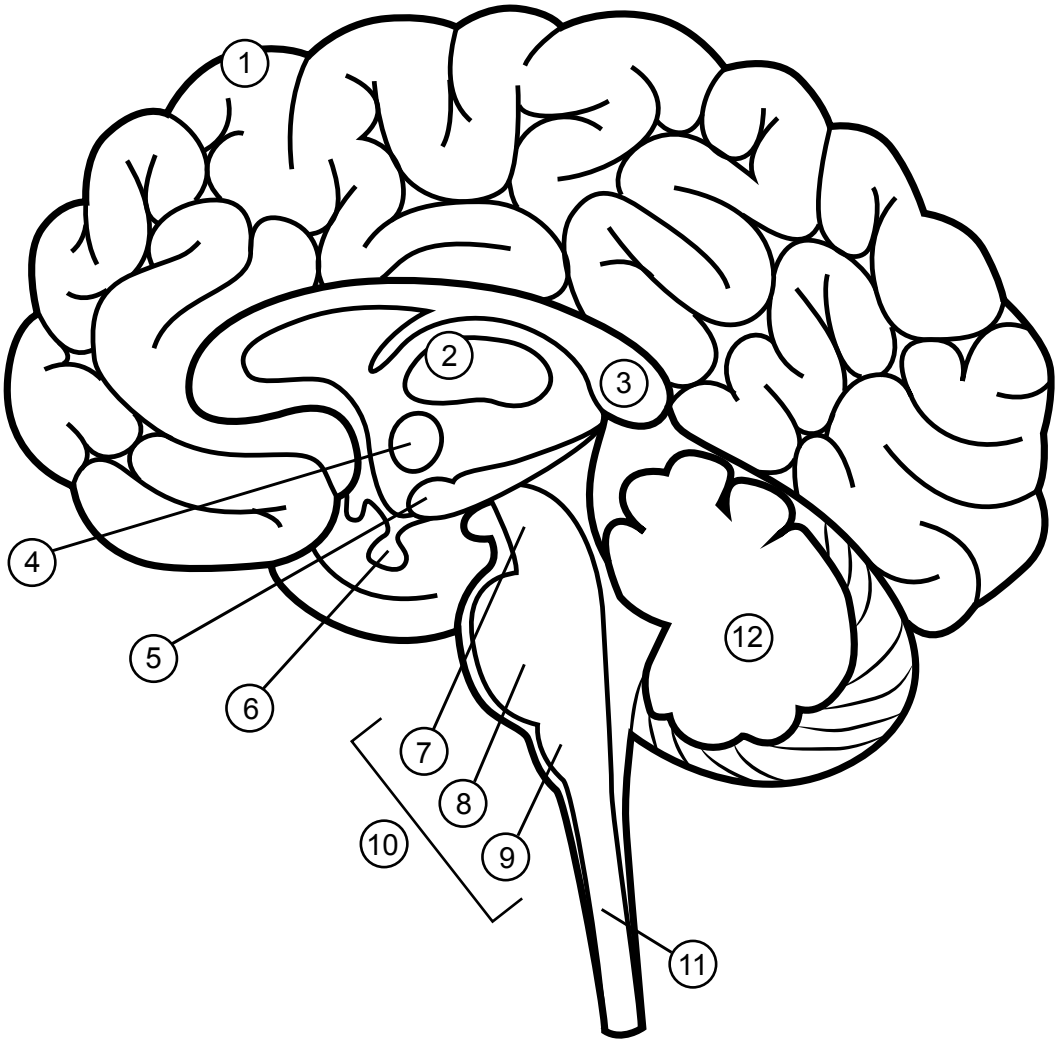
Good job! You were able to get most of the tumor out. The patient is recovering in her hospital room. The patient wakes up and she says that she feels okay. She is able to walk around her room without a problem. She does not complain of any symptoms. You check on her daily for the next few days and notice she seems sad all the time. This was unusual because she was very cheerful before the surgery. You suspect something may have gone wrong. A part of the patient's brain must have been hurt during the surgery. What part of the brain do you think was hurt? Figure out which part was hurt so you can go back and fix it.

Answer: Limbic Lobe

What's In Your Brain?

The parts of the brain have been labeled.
Your challenge is to write the correct name for each part.

For more fun brain food visit
askabiologist.asu.edu/explore/nervous-journey.



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10. _____
11. _____
12. _____

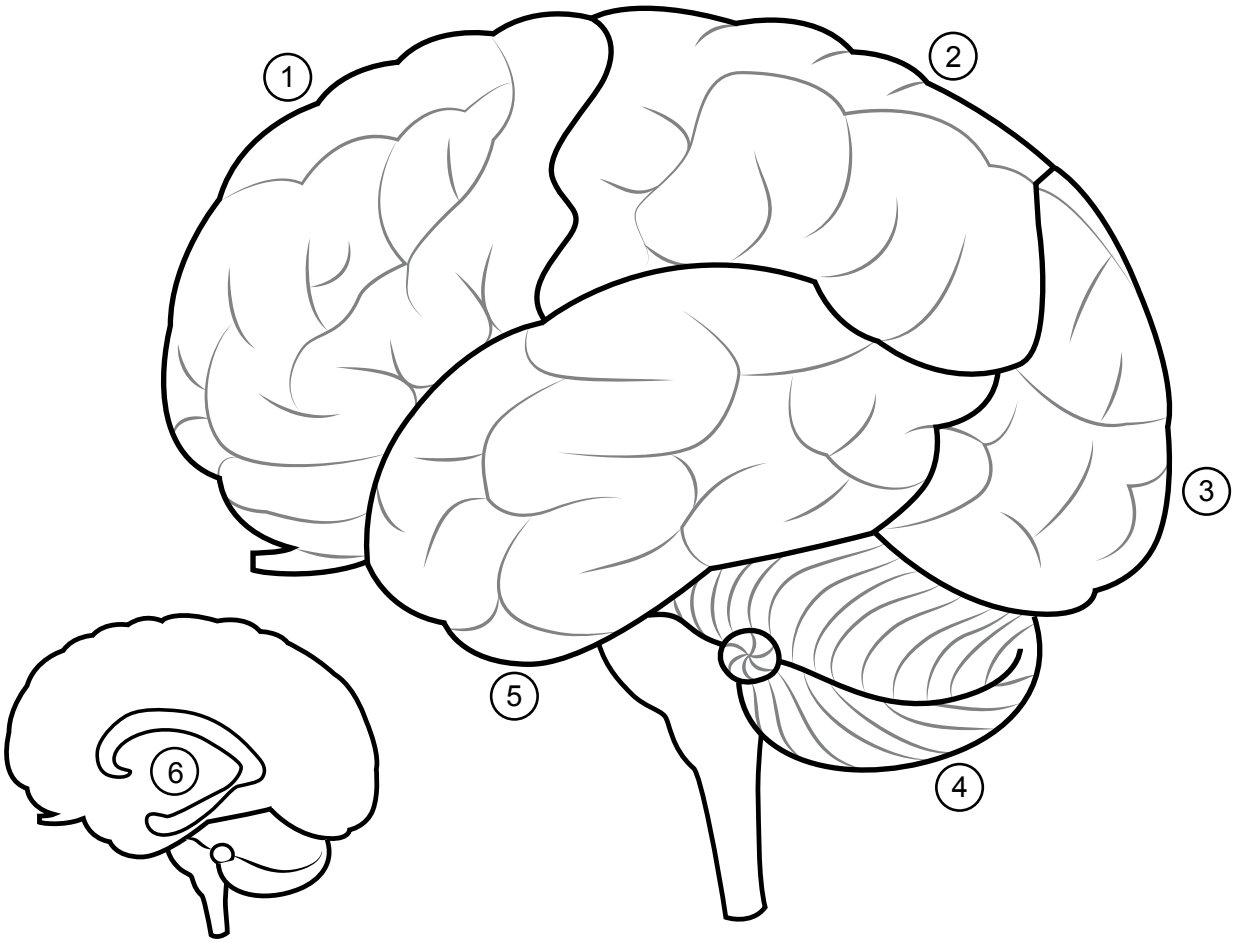
What's In Your Brain? Activity Key

1. Cerebral cortex
2. Thalamus
3. Corpus callosum
4. Hypothalamus
5. Hippocampus
6. Pituitary gland
7. Midbrain
8. Pons
9. Medulla
10. Brainstem
11. Spinal cord
12. Cerebellum

What's Your Brain Doing?

The regions of the brain have been labeled. Your challenge is to write the correct name for each region and describe what they do. If you need some help, visit askabiologist.asu.edu/explore/nervous-journey.

What two parts of the brain control stress? Read, listen and learn how a Bull Frog is helping biologists learn about stress and the brain in this Stressed Out podcast.



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What's Your Brain Doing? Activity Key

1. Frontal lobe
   - Movement of the body
   - Personality
   - Concentration, planning, problem solving
   - Meaning of words
   - Emotional reactions
   - Speech
   - Smell

2. Parietal lobe
   - Touch and pressure
   - Taste
   - Body awareness

3. Occipital lobe
   - Sight

4. Cerebellum
   - Latin for little brain
   - Fine motor (muscle) control
   - Balance and coordination (avoid objects and keep from falling)

5. Temporal lobe
   - Receive & processes sound
   - Recognizing faces
   - Emotion
   - Long term memory

6. Limbic Lobe
   - Located inside the brain
   - Controls emotions like happiness, sadness and love