Summer Camp Activities

Monday:

Draw a scientist:

Begin unit by assessing what the campers believe about scientists and science. Ask questions such as:

- Do you know a scientist from the past or present? Can you describe him/her, i.e. what did he/she look like, what did he/she do in their work environment?
- What do you think scientists do during a typical day? Where do they work?
- Why do you think the world has scientists? What do you think their purpose is in society?

Pass out drawing and coloring utensils with sheets of paper. Ask children to think about the previous discussion questions when drawing who they believe a scientist is and what he/she does.

Nervous System Kid:

One child lays down on a piece of large butcher paper. Another child traces that student so their whole body is on the butcher paper.

The children then draw their brain and spinal cord, or use cut out pictures. Have campers also draw or paste organs in the right places, make sure they get it in the right place! Have them label everything and personalize how they want.

As they design their “kid” ask questions such as: what processes does the brain and nervous system control? What would happen if there was not communication between the brain and other parts of the body?

M&M Sorting:

Introduce activity to your group by picking up a red M&M and asking: what color is this M&M? Make sure the consensus is that it is indeed red. Explain to children the visible light spectrum, the light that the human eye can see in colors red, orange, yellow, green, blue, indigo, and violet from longest to shortest wavelength: ROYGBIV for short.

2. This will open a discussion on why we see the M&M as red and why our perception of color is important for our daily lives. The following questions can be used during the discussion to introduce scientific concepts of why and how we see color:

- Why do we see this M&M as red?

  The light in the room is white; therefore the M&M reflects light located primarily in the red part of the visible spectrum while absorbing light in the other areas of the spectrum. An additional reason is that it is coated with a red sugar shell that contains red dye.

- What role might light play in what we see?
  Some light is reflected by the M&M and some is absorbed. The reflected light is what we see. Red light at the long-wavelength end of the visible spectrum is reflected by the M&M.
- What allows us (humans) to see color?
  Our eyes, structures and cells within our eyes, and our brain all work together.
- What structures with the eyes are involved?
  The lens and retina are connected to our ability to see color. The retina, located at the back of the eye, contains cone cells that are primarily used to sense color. There are 3 different types of cone cells: S- short wavelength cone cells that detect blue light, M-medium wavelength cone cells detect green light, and L-long wavelength cone cells that detect red light.
- What would happen if the color of light changed? Right now, red light is reflecting off of this M&M and into our eyes. What might happen to our perception of the color of the M&M if red light wasn't available?
  Our perception of color would change because there would be no red light available.

3.The group will now explore what happens when you look at M&Ms of a certain color under different types of light. Ask the children: what will happen if we put a red M&M under blue light? Red light? This is what they will be testing.

4. Next, the children in your group will draw 4 data tables representing the 4 different types of light used at each station

5. After completing all the stations, compare the data compiled from your students. Ask the following questions:

- Did students have any difficulties performing the task?
- Which station was the most difficult?
- Which station posed the least difficulty?
- Did the students notice any trends in the amount of time it took to complete the task between stations?
- Did they notice any patterns or trends within each station?
- Did students progressively get better at each station?
- Do the students think the environment affected their ability to perform the task?
- Did they have to adjust their behavior to perform the task accurately? Why?

Tuesday:

Planarian Observations:

Reveal to campers that scientists use planarian to study regeneration. After passing out the planarian anatomy worksheet (copy worksheet), ask children what they notice similarities/differences between planarian and human bodies. Certain points to note:

- Simple nervous systems: invertebrates, no brains or spines like humans
- Photoreceptors at top of their head act as “brains”
- Have circulatory system like us, although it is much simpler and also reproductive organs
- Have bilateral symmetry: term that describes right side of body is the same as left

2. Explain that planarian have an abundance of stem cells. Ask children if they have heard that term or know what it means. Then, tell them that stem cells are cells in the body that can become any other type of cell. Planarian have ~20% stem cells in their body, which means for every 10 cells, 2 are stem cells. If this is true, what can be said about a planarian that loses part of its body or one of its organs stops functioning? The main point is that planarian are able to regenerate quickly: a head can completely regenerate in seven days.

3. Pass out planarian to group leaders. Allow campers to examine planarian with small magnifying glasses and record their observations in their notebooks:

- Use a small ruler to measure the total length and width of each planarian
- Take the temperature of the room using a thermometer (leave a thermometer in central location)
- Note the coloration of each planarian
- Note the general mobility of each planarian; how much and how well does it move?
- Shine a flashlight on each of the planarian; how do they respond to light?
- Encourage children to note other aspects of the planarians

Beady Neuron:

1. Hand out beads, wire, and beady neuron diagram. Have campers choose 4 different colors that they will use to represent the cell body, synaptic terminal, axon, and dendrites.

2. Assist children as they assemble their neuron, making sure they understand which each part does and how they are allowed some creative freedom but should design the neuron as it is diagramed.

3. As they construct the neuron, ask them how this relates to what we know about planarian: do planarians have neurons? What types of animals would have neurons? Why are neurons are important, i.e. what would happen if we didn't have neurons?

Rope Neuron:

After assembling rope neuron, explain to children each part of the model and what neuron function it represents:

- Cell body (soma): contains genes, other cellular proteins that can regulate neuron's electrochemical signal that is given out, signal received can affect genes and other cellular proteins of that cell body.
- Synaptic terminal: at the end of the axon, electrical impulse triggers vesicles containing neurotransmitters towards synaptic terminal that will be released to neighboring neuron.
- Dendrites: bring signal to cell body, or soma, multiple dendrites per cell.
- Axon: take signal from soma to other neurons, generally 1 per neuron
- Action Potential: electrical "spike" that occurs when neurotransmitter is sent from one neuron to another.
- Neurotransmitters: chemicals that allow communication between neurons, influences how cells behave.

2. Have the person holding molecules of neurotransmitter TOSS the plastic balls to the people who are dendrites. The "dendrite people" try to catch the plastic balls. This models the release of neurotransmitters and the attachment (binding) of neurotransmitters to receptors on dendrites.

3. When three plastic balls are caught by dendrites, the person holding the action potential can throw/slide the pool float down the axon. This simulates the depolarization of the neuron above its threshold value and the generation of an action potential.

4. The action potential (pool float) should speed down the axon toward the synaptic terminal where it will slam into the container. This should cause the release of the neurotransmitters (plastic balls) that were being held there.

Wednesday:

Planarian Behavior Demonstration:

Part 1: Human and Planarian Behavior

1. Lead discussion about human behavior. Brainstorm different ideas about our actions and why we do these actions. Allow children to illustrate this on one side of a large piece of paper labeled "human behavior."

2. Lead second discussion on planarian behavior. Since campers have observed them, they can brainstorm different ideas of planaria behavior and motivations for a specific behavior. On the second half of the paper, children will illustrate what they believe are planarian behavior and motivations, labeled “planarian behavior.” (Or the journals)

Part 2: Planarian Behavior
1. Obtain an uncut planarian, or multiple planarians depending on resources, that has not been fed for each group demonstration. The group leader will then begin the first taxis experiment: food stimulation or chemotaxis
What happens when you give them food? (chemotaxis)
(For children to see how planarians will use chemotaxis (will move towards an “odor”), they will need to put some bloodworms into a petri dish containing some planarians in spring water. The planarians should move towards the bloodworms and will feed on them. Without a microscope, the students should be able to see the planarians darken as they eat.)

Have campers make notes on the behavior in their notebook. Questions that can be used to prompt the students to take detailed observations include:

- Do all the planarians move towards the food?
- Do they move at the same rate towards the food?
- How might you explain the differences in these behaviors?

To view the digestive tract, have the children look at the planarians under a microscope. To best view the planarians under a microscope, it might be best to put them on a Petri dish containing frozen spring water.

2. Next, use the same planarian to demonstrate light sensitivity, or phototaxis.
While planarians will move towards a food source, they will move away from bright light. In a darkened room, shine a bright, focused light onto a Petri dish containing planarians. The light should not encompass the whole dish, but should be a small “spotlight” in the dish.

Have campers make notes on the behavior. Questions that can be used to prompt the students to take detailed observations include:

- Do the planarians move towards or away from the light?
- How quickly do they move out of the light?
- Do they maintain the same speed once they’re out of the light, or do they change their rate of movement?

3. Finally, use the planarian to demonstrate sensitivity to external pressure by gently touching the planarian with a toothpick, known as mechanotaxis. Have the children observe how the planarians respond to a light touch from the toothpick. Have students make notes on the behavior. Questions that can be used to prompt the students to take detailed observations include:

- Do the planarians move towards or away from the touch?
- What movement is seen?
- How quickly do they move?

Cut Planarian Hypothesis Generation:

1. Children will begin to make hypotheses on their cut planarian from the previous day. The hypotheses should focus on the types of cuts they made and how these cuts could affect the behavior and regeneration ability of the planarian. Remind campers of what was discussed yesterday about regeneration, have students refer to their anatomy sheet and notebook to remind themselves of the cuts they made and how it affects the planarian's body. Allow campers to develop their own hypotheses and provide the appropriate scientific reasoning as to why they have the hypotheses that they do. Emphasize that a good hypothesis should be testable; that which cannot be proved or disproved is outside the realm of experimental science. In addition, a hypothesis should be developed using scientific reasoning.

Possible questions that could be used to engage campers in thinking about variables that might impact regeneration include:

- Will certain parts of the body regenerate faster than others? Why do you think this may be?
- Do you think the progress of regeneration will be affected by the shape of your cut (i.e., whether it is straight, curved, etc.)?
- What sort of environmental factors do you suppose might affect regeneration?
- How will their behavior be affected because of these cuts?

2. After all hypotheses are generated have children repeat the experiments from activity 3 in groups of 3-4 with a group leader guiding them. They should be recording their observations in their notebooks, in the same manner as those recorded in activity 3 for the control group.

3. Finally, children should compare the observations made about the control group and the experimental group and write a summary of the similarities and differences. As a group, discuss what these similarities/differences are and brainstorm possible reasons why these occurred.

Brain Models Activity:

1. Set up prepared balloons with marbles inside. Explain to campers how the marble represents someone's brain and that the balloon is the skull. Demonstrate differences in how the marble hits the sides of the balloon with or without water inside the balloon. Then, explain that the water acts as the cerebrospinal fluid (CSF). Lead the children in the following discussion:

- What did you notice that was different between the two balloons?
- What did the water do?
- Do you think this is a good model of a head? Explain your answer.
  - How would you make this model better?
  - What are some of the strengths and weaknesses of this model?

After the balloon skull introduction, tell the children that the next activity will let them test how well the CSF "cushions" the brain using the egg drop activity.

3. After establishing the importance of CSF in protecting your head, proceed with egg drop activity. Have two water bottles each with one egg. One will be used to show how high of a distance is necessary to produce a crack in the egg. Depending on how many students per group you have, you could have students do this in pairs or groups of 3-4. Make sure children are measuring the heights they are dropping the egg to compare with the rest of the group. Demonstrate how to use a yardstick if necessary, measuring in centimeters since it is the scientific standard of measurement. Make sure they record this data in their notebooks.

4. Next, explain that we will be testing the effects of the egg with repeated injury from a single short distance. Some introductory questions can be:

- Do you think hitting your head repeatedly over time will cause damage?
  - What if there are long periods of time between hits?
  - What if there is no obvious damage after you hit your head?
  - Are repeated low intensity hits to the head more or less damaging than one big hit?

Allow groups to measure their distances and also record how many times it takes for the egg to crack at one particular short distance. As a whole group share the distances and how many times it took for the egg to crack. Make sure campers record data in notebook. From these activities discuss the following:

- Why is it important to protect your head?
- What happens when you get hurt? When you bruise your arm? What about when you bruise your brain? Can the body always repair itself or are some areas permanently damaged?

• Some animals can re-grow nerves into their brains—do you know about these animals?

Brain Swim Caps:
Pass out one swim cap per child and a variety of Sharpie markers. Show the children figures of the human brain and provide a list of structures the children can draw on their swim caps. They can be as creative as they want, as long as the structures are in the right place! Make sure you ask questions that assess how well the children have learned from the brain dissection.

Thursday

Planarian Regeneration:
1. Group leaders should demonstrate good cutting technique with plastic coverslips using the steps below(1-4). Explain to the children the importance of how we cut the planarian since we want them to regenerate during the week and not be so damaged that they cannot. Also, this would be a good time to discuss ethical issues of using model organisms, why it is important to treat the planarian with respect during our studies. As a group of 3-4 children, they will come up with two different cuts, to be repeated two times for a total of 4 planaria used to demonstrate the cuts. Explain why it is a good idea to repeat the cuts for experimental purposes: outliers, mistakes, etc. Campers will then make cuts such as demonstrated with supervision:
1) Take two different four-chambered Petri dishes with lids (or four small petri dishes per cut type), and explain that each of the dishes should be used to house the worm segments that result from one kind of cut. For example, if the worm were bisected to yield head and tail segments, the four quadrants on a single dish could be labeled “Cut 1, Worm 1-Head,” “Cut 1, Worm 1-Tail,” “Cut 1, Worm 2-Head,” “Cut 1, Worm 2-Tail” (where Worm 2 is used to replicate the first cut). Remember to write on the bottom of the dishes and to place your group members’ initials on each of the dishes. Fill each dish approximately halfway with spring water. Ask children why you choose to label the bottom of the plates and not the tops.

a. Use one Petri dish with one worm for the demonstration

2) Place a damp filter on a Petri dish filled with frozen spring water to use as a dissection
station. Using a plastic pipette, place a worm from the chilled stock solution onto the coffee filter. Cut each worm using a plastic coverslip. It is possible to use either a microscope or a magnifying glass to see what types of cuts are being made. Demonstrate how the coverslip can be cut or bent to yield curved or jagged cuts if desired.

a. Use pre-chilled planarians if possible as part of the demonstration.

b. Tell children that if a magnifying glass is being used when they do the cutting that one child should hold it in position for the child who is doing the cutting.
c. Alternatively a larger magnifying glass and stand can be used

3) Remember that Cut 1 should be replicated in two worms. Cut 2 should also be replicated using two worms.

a. For the demonstration, cut a single worm in half widthwise on the overhead projector, separating the head from the tail. This will make for a quick cut and eliminate the need to magnify the worm, as the procedure will be magnified on the overhead. Emphasize caution when using the coverslips to cut the planarians.

4) After the worms have been cut, transfer the worm segments to the appropriately labeled Petri dishes.

2. Campers will record what they believe will happen on Thursday to the planarian they have cut, what they will look like, how they will be different than the uncut planarian they have observed today. They should also provide some fact-based reasons for why they believe the planarian will look like what they have drawn or described.

3. Campers can also model the cut(s) they had made on their planarian with modeling clay that they will eventually keep. The modeling clay will be kept in petri dishes with their name and date on the bottom, just like the experiment.

Brain Dissection:

1. Open with newspaper activity:

Objective: to give campers a sense of how evolution has worked to produce a highly folded or gyrencephalic brain. Growth of the brain across evolution was constrained by the size of the skull. Ask children to brainstorm some constraints on skull size. Probably, skull size is limited because of bipedalism, hard to hold up a heavy head with a skinny neck and pelvic size--birthing canal of mothers. So instead of simply growing bigger in area, the brain became more folded, convoluted, to fit into our relatively stable sized skull to maximize surface area in a fixed space.

Each child takes a single piece of newspaper and unfolds it. They are told this represents the area of the brain (not exactly the same but still a good analogy). But it has to fit into a circle about 6 inches in diameter. Have campers think about solutions to this and how they would fit it in. Give them a few min. to think and then instruct them to try out one of their ideas. Campers may crumple up the paper into a fist-sized ball. This is actually very close to what happened with evolution. Others may shred the paper, etc. and teachers can talk about how the connectivity needs to stay intact so shredding wouldn't be as evolutionally efficient.

2. Ask children to think about how the anatomy of the brain and the structures affected by injury interact to cause the functional symptoms of injury. This discussion should motivate the dissection. To introduce the sheep brain dissection, ask:

- How might we study head injuries?
- What information might we need to know about the brain to understand how brain injury can lead to changes in behavior or function?
- Why are head injuries so serious?
- What happens when you get a head injury?
- How can we identify the neuroanatomical locations affected by head injuries?

One cannot simply take out the brain to examine an injury. There are some imaging techniques (CT, MRI, etc.) that will be discussed in later lessons. Lead children to think about using animal models for identifying common anatomy of the human brain.

- Why is it important that we know the anatomy of the brain?

3. The group leader will demonstrate proper technique and safety rules. Then, the campers will receive their dissection materials and sheep brains.

4. The guide will go through the exterior of the brain, a mid-sagittal cut, and coronal cuts. It might be appropriate for each group of 4 to pair us, with one student reading the guide and the other doing the cutting and then switching halfway through the guide. One pair can do a coronal cut while the other does a mid sagittal cut so that each group of 4 children can see the 2 different cuts. Allow campers to work at their own pace and take the time to explore the brain.

5. Finally, lead a discussion asking: which structures were more noticeable/interesting? Then with the poster, have campers identify key structures and fill in the poster with the new vocabulary words they have learned.

Activity 3: Eye Dissection

1. Begin lesson with a demonstration of proper technique and safety rules. Distribute Camper Dissection Manual and overview the structures that they will identify.

2. Pass out dissection supplies and specimens. As they complete the dissection, have the children record observations in words or drawings in their notebooks. Ask them to write down interesting findings made during the dissections and provide plenty of assistance.

3. After cleaning up their work areas and disposing of the specimen, bring out the large poster of the eye. Lead a discussion with the following questions:

- Which structure in the eye did you find most interesting?
- Can you name the structures of the eye?
    Have the students write in the names of the structures on the large eye poster. This is to be kept in class.
- What are the functions of the optic nerve, cornea, lens, iris, and retina?

TBI Cupcakes

1. Ask campers about their brain dissections from earlier in the day:
    - What structures seem particularly susceptible to injury?
    - How might structures in the middle of the brain be injured?
    - What types of injuries do you know of that can cause TBI?

2. Based on this discussion, children will receive their undecorated plain cupcake. Using frosting, they can decorate their cupcake to represent different types of brain injuries.

3. As a follow up, have campers draw a connection between the planarian they worked with and the brain models. How could a planarian model help scientists figure out ways to treat people with TBI? What is special about the planarian for this purpose? (Hint: regeneration!)

Friday (3rd - 5th Grade Campers)

Visit to Dr. Becky Fuller's Lab

(http://www.life.illinois.edu/fuller/): Check out her lab website to get an overview of her research. Becky had us split the group into three separate groups and sent us off to one of three stations.

1) Fish capture: We walked to Boneyard Creek and caught small fish. Daniel Welsh (one of Becky's grad students) showed the kids how he captures fish for his research and identified what we found.

2) Mini-lecture and demo of spectrometer. Becky Fuller basically presented an overview on how we perceive light and demo'ed a spectrometer she uses in her research. She had the kids pick items around the room of different colors and showed them the parts of the light spectrum that are reflected by that item (i.e., the colors we perceive).

3) Observing fish eggs and fry under a microscope. Another one of Becky's graduate student's outlined the ontogeny of some of the fish species they study in the lab. Under microscopes the kids could see eggs at various stages of development and fish fry (i.e., baby fish!).

Visit to Rhanor Gillette's Lab

(http://www.life.illinois.edu/slugcity/Home1.html) Rhanor was not present but his graduate student Jeff Brown was gracious enough to outline some of the neuroscience research performed in the lab (see website for details) Jeff first gave a short lecture on what sort of research is performed in his lab while demoing some of the instruments he uses for his own work. After speaking, he showed off all the lab's animals. The kids loved it all and had a million questions about the fish tanks, tarantula and hamster. Jeff took out the spider and the hamster and allowed the kids to pet both. Finally Jeff took us next door to show off his octopus.

Saltatory Conduction

Saltatory conduction is the way that an action potential travels down a myelinated nerve fiber. The action potential "jumps" from node to node thereby increasing the speed of transmission. To model saltatory conduction (and to have a bit of competition), divide players into two equal teams. Each team should line up with players behind each other and separated by about 2-3 feet. Each player represents a "node of Ranvier" along a myelinated nerve fiber. The first player (the first "node") is given a ball. The ball represents the action potential. When someone says "GO!," the first player must bend over and pass the ball through his or her legs to the next player. This next player must keep the ball moving by hitting the ball to pass it to the next player in line. The ball should travel through the legs of all players until it gets to the last player. In this way, the ball (the "action potential") will jump from person to person ("node to node") as it makes its way down the line of players (the "nerve fiber").

Friday (Kindergarten - 2nd Grade Campers)

Draw A Scientist (Part 2)

End unit as we began it, by assessing what children believe about scientists and science after their experience in this outreach. Ask questions such as:

- How has your opinion or view of scientists changed?
- Now, what do you think a scientist does in a typical day?
- What purpose do you think scientists serve? What is their role in society?

2. Pass out drawing and coloring utensils with sheets of paper. Ask children to think about the previous discussion questions when drawing who they believe a scientist is and what he/she does.

Optical Illusions

1. After dissections, campers should feel comfortable with the idea that the eye and brain work together to form images. Use this to ask: are there any examples of how our

brains influence what we see? If they don't mention illusions, show them various optical illusions from any number of helpful apps or websites (iPad or Kindle Fire).

2. Ask children if they are familiar with any other types of optical illusions and if they can draw them out or describe them to the class.

3. Pass around a variety of other illusions and ask children what they see.
Websites:

- http://www.michaelback.de/ot
- http://www.visualillusion.net/Preface/
- http://www.lottolab.org/articles/illusionsoflight.asp

This is an excellent site with illusions connected to light and color that are freely available for use in educational settings at http://www.lottolab.org/downloads.asp

Mirror Tracing Game

1. First you trace the shapes as fast as you can. (Shapes may need more copies)

2. Next place the mirror behind the shape and trace it again. However, this time you can only look at the mirror and not the paper.

3. Have the campers try each of the four shapes. Which shapes are easiest/hardest to trace?

Paint Chip Game

Designate 7 plates with each of the colors of the game (Red, Blue, Green, Brown, Orange, Purple, Yellow). Use the bags of paint chips and have the children try to classify each paint chip by having them place it on a plate of which color they think it most closely resembled. They should be given a set amount of time to perform the categorization. (using a stopwatch or phone). Compare side by side the classifications of two or more children.