Neuroscience for Kids
http://faculty.washington.edu/chudler/neurok.html

Our Sense of Sight: 1. The Eye and its Connections

Out of Sight!

Featuring a "Class Experiment and "Try Your Own Experiment

Teacher Guide

WHAT STUDENTS WILL DO

- PREDICT and then MEASURE their central and peripheral visual fields with eyes focused straight ahead
- PREDICT and then MEASURE their central and peripheral visual fields when eyes are allowed to move
- CALCULATE the class averages for sizes of visual fields
- LIST advantages of a wide field of vision and of peripheral vision
- DIAGRAM the visual pathway
- DESIGN and conduct experiments to further study the eye and its connections, for example:
    - TEST their ability to function with reduced fields of vision
    - SIMULATE animal visual fields
    - DEVISE an eye safety questionnaire and administer it
    - INVESTIGATE the blind spot

SUGGESTED TIMES for these activities: 45 minutes for introducing and discussing the activity, 45 minutes for the "Class Experiment;" and 45 minutes for Explore Time and "Try Your Own Experiment."

SETTING UP THE LAB

Supplies

<u>Optional supplies</u>

Eye model
Wall poster of the eye
Eye chart (type used in ophthalmologist's office)
Textbooks with diagrams of visual pathways

<u>For the Class Experiment</u>

One **Vision Disk** or **Vision Hat** for each group of 3 to 5 students
Set of letter cards for each group
Recording sheet for each student (See the template at the end of the Student Guide.)

A Vision Disk and set of letter cards are available from Carolina Biological (www.carolina.com) for about $30. You can purchase one set and use it as a template, or make the Vision Hat below.

To make more Vision Disks: (have adults do this outside of class time)

Poster board
½" to ¾" brads
Scissors
Exacto knife or single edge razor blade (adult use only)

Alternative to the Vision Disk—the ***Vision Hat (See instructions below for creating the hat)***

Inexpensive baseball caps with adjustable backs
Poster board—enough to make a Visor Extender for each group of 3 to 5 students.
The board can be white or any color on which black markings will clearly show. One 28" x 20" sheet of poster board will make about 6 visor extenders. For 6 sets of the other components, add another sheet of poster board.
Construction board that is slightly heavier than poster board
½ " brads—one for each hat
Tape (transparent)
Scissors
Stapler—heavy duty
Punch tool (pointed object such as a metal skewer)
Exacto knife or single edge razor blade (adult use only)
3" square post-it notes
Black Sharpie markers
Templates at the end of this unit, for hat components

<u>For “Try Your Own Experiment”</u>

Colored paper for further peripheral vision experiments; a variety of bright and pastel colors is helpful, as is a variety of sizes of sheets of paper

Geometric shapes (about 3” squares and other shapes) or paper for students to make these, for further peripheral visions experiments. These may be black or colored—if colored, they can also be used to test color peripheral vision.

Blind spot demonstration diagram. Download this diagram at:
http://faculty.washington.edu/chudler/retina.html

Materials for making animal masks (construction paper, elastic, bicycle mirrors)

Long and short tunnel vision masks: templates are at the end of this unit.

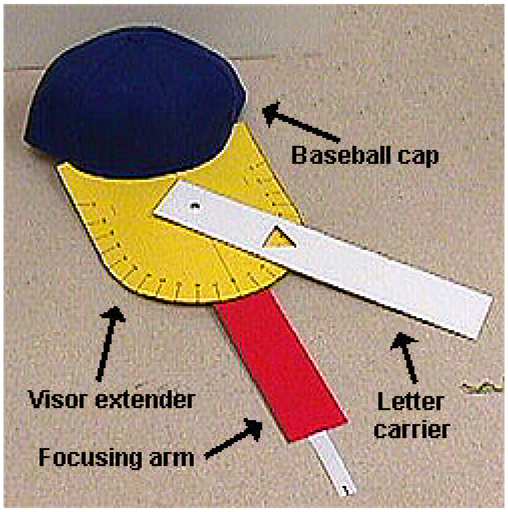
15” of narrow, stretchy (not stiff) elastic tape or elastic thread for each tunnel mask.

Writing paper for student use in devising an eye safety questionnaire.

Other Preparations

- For the Class Experiment, point out that each student has a **Recording Sheet** at the end of the Student Guide.
- **Construct a chart** on the board where data can be entered for class discussion.
- **Decide the size of the student groups**: each group should have at least three—one Subject, one Recorder, and one Tester. Because each group must have one Vision Disk or hat, divide the class according to the number of disks or hats you have.
- For Try Your Own Experiment, **prepare materials** in the Supply list and put them out on an “Explore” table after the Class Experiment.
- **Modify activities for exceptional students**:
    - Make sure a student who has low vision is seated in a well-lighted area.
    - Students who are blind can participate in activities such as teaching the class some words in Braille or helping prepare a three dimensional model of visual pathways. Students who are comfortable talking about their blindness might discuss how they find their way around while walking. People with other low vision problems may want to discuss their problems and solutions. Some may not want to share this information.

- **MAKE YOUR OWN VISION HAT**



The Vision Hat is an alternative to buying a Vision Disk. It is easiest to have adults make these outside of class time. Once you gather all the materials, the first hat may take 45 minutes, but subsequent ones will take much less. **The work is well worth the effort: students are always amazed at the small size of their central visual fields, and at the fact that peripheral vision gives such limited information.**

1. The photograph above will help in constructing the Vision Hat.

2. Keep the visor of the baseball cap FLAT: do not let students bend it (as most do with the caps they wear).

3. Cut out the "**visor extender"** template (from the end of this unit) along the dark lines and use it to make the visor extender for the cap from poster board.

4. After you have cut out the visor extender, place the template over the poster board visor and make a small dot at the end of each black line (that you see on the template) at the rim of the poster board. Then mark in the dot in the middle of the visor extender where you will punch a hole for a brad. Using a ruler, line up each dot you made at the periphery with the center dot, and draw a **1.5 cm** line to match those on the template. At the top of each line, write the number shown on the template. (N.B.: These numbers do not accurately measure degrees, but do allow students to make measurements and to compare results.)

5. Punch a small hole at the black dot in the center of the visor extender for a brad. (The extender will be stapled to the visor of the cap later.)

6. Cut out the templates for the "**letter carrier**," the "**focusing arm**," and the "**focusing line**" from the end of this unit.

7. Use poster board to make the focusing arm. Attach the focusing arm to the visor extender with **tape** so that the distance from the **inner edge** of the visor extender to the **end of the focusing arm** is close to **12 inches**. **This arm does not move**.

8. Use the **focusing line** template to make a focusing line from regular computer or writing paper; use a black Sharpie pen to make the vertical line as indicated. Fold the paper along the fold line and tape it to the end of the focusing arm, with the black line facing inward (toward the person wearing the hat.) In the photograph the focusing line is lying straight out, but when the hat is used, it should hang vertically.

9. Using board slightly **heavier** than poster board, make the letter carrier. Use an exacto knife or single edge razor blade to carefully cut out the triangle in the end of the letter carrier to allow viewing of the numbers on the visor extender. With a punch tool, make a hole in the other end of the letter carrier (at the dot) for the brad that will attach this arm to the visor extender.

10. Attach the letter carrier to the visor extender with a brad and make sure the triangle window shows the numbers on the rim of the extender when it is moved around the rim.

11. Staple the completed visor extender (with the attached letter carrier and the focusing arm) to the visor of the cap, in several places. Try to get the straight line in the center of the visor extender to line up with the center of the cap. Most caps have stitching on the crown that indicates the center, so you can line the extender up. It is not crucial to get the extender exactly lined up with the center of the cap, because the extender has its own built-in focusing line that is also the reference point for measuring the visual field.

12. For letter cards, use 3”x 3” inch post-its. Turn the post-it sticky side up, and write two or three upper case letters about one inch high at the bottom (non-sticky part) of this side of the paper with the black Sharpie pen. For each test of a student, stick one of these letter cards on the end of the letter carrier so that the letters face the student wearing the hat.

13. Follow detailed directions in the Student Guide for using the hat.

- **MAKE TUNNEL VISION MASKS**

To make tunnel vision masks, use the drawings on the last two pages of this unit. These two pieces **together** make **one short tunnel mask**. Print out as many copies of these pages as the number of masks you need: **students can use the computer paper itself as a mask.**

1. Cut out the two pieces of the mask and tape the sides with the dotted lines together, overlapping them so that the edge of one side meets the dotted line of the other (about one inch overlap). Be sure that the labels for “NOSE” and “FOREHEAD” are on the **same side** of the template. Note that the asterisks should **not** be matched—one should be on each side of the mask.

2. Tape the mask into a circular form by overlapping the two free ends about 1”.

3. Staple the 15” piece of elastic at the spots marked by asterisks.

4. Students should position the mask on their faces as indicated by the markings for “nose” and “forehead.”

5. To make a **long tunnel mask**, tape a strip of paper three inches wide to the straight side of the mask before forming it into a circle.

6. Follow detailed directions in the Student Guide for use.

INTRODUCTORY ACTIVITIES

Give students initial information

Introduce the **Eye and its Connections** to the class according to your teaching practices; e.g., with reading, lecture, and discussion before lab work (the **Teacher Resource** accompanying this unit gives background material). In addition to covering the anatomy and physiology of the visual system, for these experiments you will want to introduce the concepts of field of vision, central and peripheral vision, the blind spot, and the fovea. Other topics that may interest students include animal vision, eye safety, refractive errors in eyes, dark adaptation, and other topics you think might come up in the "Try Your Own Experiment" section.

Introduce lab activities with a demonstration

When students enter the classroom on **lab day**, you can **introduce the activities** by asking them to sit facing forward and to keep eyes and heads forward. Starting at the back of the room**, walk slowly forward while you ask students to raise their hands when you come into view** (remind them not to move **head or eyes**), and then to raise their hands again when they can **identify** that it is you. Walk slowly to the back of the room and ask when you disappear from sight. Ask questions to engage students in the concepts of field of vision, peripheral vision, and central vision.

Alternatively, use the **Scenario** at the beginning of the **Student Guide** to involve students in a short discussion.

Out of Sight!

CLASS EXPERIMENT

The sections below match those in the Student Guide. The comments guide teachers in preparing and teaching the labs.

LAB QUESTION

After introducing the Lab, help students to write the following Lab Questions or ones that match closely:

What is the area, measured with a Vision Disk or Vision Hat, in which we can see objects with peripheral vision? In what area can we see well enough to read?

PLANS AND PREDICTIONS

Encourage students to add their own knowledge and experiences in order to make predictions after you have provided background information. When students are in their groups, have them look at the Vision Disks or Hats and predict where they will first see an object with peripheral vision, and where they will be able to read something.

Talk about how when we see something "out of the corner" of an eye, we almost always immediately turn our heads or eyes to look directly at the object, especially if it is moving. Thus peripheral vision brings things, especially moving things, to our attention and allows us to adjust our eyes to bring an image into central vision.

PROCEDURE

1. **Introduce safety precautions:** Follow all standard lab safety guidelines for preparing and teaching the activity; e.g., take precautions to avoid germ spread; wash hands; use equipment properly.

2. **Establish** the number of students in each group.

3. **Explain** the steps in the Class Experiment. These are listed in the **Student Guide,** under **Procedure**. A good plan would be to **demonstrate Steps 5 through 11** with one student group for the entire class.

4. **Instruct** students to use the **Record Sheets** at the end of their Student Guides.

5. Remind students to **clean up** the lab when they finish.

DATA AND OBSERVATIONS

- **Note** that the numbers on the Vision Hat are arbitrary units and do not exactly match the Vision Disk numbers (if you have a Vision Disk). They are only for the purpose of comparing results among Subjects.

- See that students record observations on their Record Sheets. All subjects should connect the center dot on the **diagram** of the Vision Disk or Hat with the "S" and then with the "R" marks to demonstrate the angles in which they can **Sight** something in peripheral vision and in which they can **Read** something **without moving eyes**. **Shade in** the reading angle. With **dotted lines**, they should draw lines for fields of vision when allowed to move their eyes.

- Everyone can calculate the class average for the two measurements made without moving eyes: Sighting and Reading.

- Have the data recorders from each group list their results in a prepared chart on the board.

- Students should write down anything that they found interesting during the experiment.

ANALYSIS: THINK ABOUT IT!

The following questions can encourage thinking about this activity; add your own questions. (*See also the specific questions in the Analysis section of the Student Guide.)*

- What is the explanation for seeing something "out of the corner of your eye," or when you are not looking directly at it? (Photoreceptors in the periphery of the retina receive light and send information on to the brain, but our eyes fixate and focus on something only when its image falls onto the center of the retina.)

- How is peripheral vision important? When do you use your peripheral vision? (Sports, walking, biking, driving (if old enough), in dangerous situations—something moving toward you.)

- How do your results compare with those of other groups?

- Can you explain any differences you see among the observations? (Variation in fields of vision; some people may have eye problems; perhaps some people moved head or eyes.)

- Do you have any **direct evidence** from your experiment to show that people have a fovea, or rods, or cones? (There is no direct evidence from these activities; this would require looking with special microscopes to identify parts of the retina, and recording from nerves with tiny electrodes to show how different areas of the retina convey different information.)

- How does visual information get from the eye to the brain? (A diagram is found at http://www.hhmi.org/senses/b/b150.htm, and another at http://www.brainconnection.com/topics/?main=anat/vision-anat2

- Discuss what the results mean in terms of the concepts learned in the Background lecture and discussion on the eye.

CONCLUSIONS

Students should:

- State how the Lab Question was answered in their experiments.

- List three things (or a number you choose) they think are important about today's experiment. Focus students by asking such questions as: How is peripheral vision important to us? What do our brains do with sensory (particularly visual) information? Can you investigate some questions on your own? Do scientists know everything there is to know about vision?

- List ways to improve this experiment or further things to test.

Out of Sight!

TRY YOUR OWN EXPERIMENT

LAB QUESTION

After students have completed the Class Experiment, indicate the lab bench where additional materials are available for "Try Your Own Experiment" and let them **explore** the items. Then **brainstorm** with them for ideas such as continuing the field of vision experiments, demonstrating the blind spot, finding out about tunnel vision or other restricted vision, or investigating eye safety.

Questions can help students to formulate plans: What information does peripheral vision give us? Are all parts of the retina the same? Do some animals have different fields of vision from ours? What happens when people lose part of their field of vision?

Ask questions to encourage thinking about how the sense of sight works; for example: How do glasses correct vision problems? Does anyone in your family have vision problems—cataracts, blindness, glasses? How do doctors and others help with these problems? Do you think most people are careful about their eyes? Students can investigate some of these topics for extra credit or can bring information to class for discussion.

See that each group defines a Lab Question, as they did in the Class Experiment.

PLANS AND PREDICTIONS

SUGGESTIONS FOR EXPERIMENTS

(Add your own ideas to this list. The Student Guide also suggests some of these experiments but does not contain all details given here.)

1. **Continue** the field of vision experiments:

    - Make a set of geometric **shape cards** to fit the Vision Disk or Hat arm—test to see at what point people can recognize a shape.

    - Use brightly **colored cards** in the Vision Disk or Hat to see where in their peripheral fields of vision subjects can name colors.

2. **Restricted field of vision**

   - Sometimes a hat, a hairstyle, a person or object next to us, or a medical problem with the visual system (e.g., some stages of retinitis pigmentosa and glaucoma) restricts our field of vision**. Use tunnel masks** (directions on page 6) **to limit the field of vision** while performing a defined task, and score the performance with and without the masks. For example, if space permits, have two people stand side by side, then move apart with outstretched arms, so their hands just touch. They can then bounce a small rubber ball to each other ten times—students must turn bodies a bit sideways but are **not allowed to move their feet** (except to get a missed ball). Record the number of catches, and then repeat the bounces wearing short and long masks: templates are at the end of this Guide.

   - Make **masks to simulate the field of vision of different animals**. For example, **birds** such as robins or chickens can see only to the side, so students can construct a mask blocking forward vision. (Note that this simulation is not quite accurate because these birds have eyes **pointing** to the sides and can focus better than a person with front vision blocked.) A **horse with blinders** can see only forward, a **flounder** can see only above. Perhaps some ingenious students can mimic a **dragonfly** by using bicycle mirrors (seeing almost 360 degrees), or a **snail** with moveable eyestalks, seeing in two different directions at once. (Notes: the dragonfly with its compound eyes does not have the ability to see fine detail [acuity] that we have with our refractive eyes. Snails have image-forming eyes and can see patterns, but do not have good acuity.)

3. **The retina:** From the class lecture and discussion, students should remember the **blind spot**, where the optic nerve leaves the retina. A student group can show the presence of this area and can **predict** the distance a diagram must be from the eyes in order to demonstrate the blind spot. A diagram to illustrate the blind spot may be found at: http://faculty.washington.edu/chudler/chvision.html Ask students if they can figure out why the term "blind spot" is also a figure of speech—as in, "she had a blind spot when it came to her son's behavior…" Or, ask what is meant by the blind spot when driving a car.

4. **Eye safety:** Do most people take adequate safety precautions for their eyes? Students can devise a written questionnaire on eye safety and predict the average score their classmates will achieve. Do most people miss the same questions? What can be done to make people aware of ways to take care of their eyes? The National Eye Institute has a safety quiz (http://www.nei.nih.gov/pubpat.htm).

HOW TO DESIGN A GOOD EXPERIMENT

This section is reproduced from the Student Guide:

In designing experiments to answer questions like these, keep in mind what a **successful investigator** must do:

- Ask a **very specific question**: not, for example, "Can people perform well if their fields of vision are restricted?" but rather, "If a person wears a tube-shaped mask six inches long, how well can he or she catch a ball compared with not wearing it?" It's good to have the general question in mind, but ask a narrow question for each experiment.

- Be sure you understand the **control condition** for your experiment, and then **change only one thing, or variable,** in the experiment.

- For example, if you do a "tunnel vision" test with masks, you can define performance without a mask as the control, and with a mask as the variable. To add another variable, change the length of the mask.

- Researchers try to change only one variable in a new experiment after they do a control experiment. Sometimes this is difficult, but at least they must be aware of other variables, write them down, and think about what effects they might have.

- Some activities are not experiments but rather demonstrations. For example, you may find a way to demonstrate the blind spot, but this is not an experiment. To make your activity a real **experiment**, make a **prediction**, **test** the prediction, **analyze** the results, and draft **conclusions**. For example, predict what distance a diagram must be from the eye to demonstrate the blind spot, then test your prediction. Try changing other variables, such as lighting conditions.

- If you make up an eye safety test, predict the scores you think people will get. Keep it short, perhaps ten questions. Predict whether you think people will miss the same questions.

- Keep good records of everything you do.

PROCEDURE

- **Introduce safety precautions**:

  Follow all standard lab safety guidelines for preparing and teaching the activity; e.g., take precautions to avoid germ spread; wash hands; dispose of chemicals properly; use equipment properly.

- If time is limited, restrict the number of materials you put out for experimenting.

- Before students begin their experiments, have each group write a simple plan that includes a **question, a prediction, a list of steps** they will take to answer the question, and **data sheets** or graphs (if needed).

- The list of steps in the experiments should include comments on the control system and on the variable being tested.

- **Approve** each group's experiment before they begin.

- Remind students to keep **good records**.

- Students should **clean up** the lab when they finish.

DATA AND OBSERVATIONS

- Make supplies available to students.

- Help students think about what data to gather and how to organize it.

ANALYSIS: THINK ABOUT IT!

The following questions can encourage thinking about the activity; add your own ideas. (*See also the specific questions in the Analysis section of the Student Guide.)*

- Have each group present its findings to the class in a quick oral presentation (two to three minutes)

- How do your data help to answer your Lab Question?

- What was the control experiment or condition for your experiment? What did you change or add as your variable?

- Did you make sure to change only one variable? Were there variables you could not control?

CONCLUSIONS

(See also the questions in the Student Guide.)

Ask students how certain they are of their conclusions. Would they need more evidence to make their conclusions more secure?

Each group should write a final conclusion, making sure it addresses their Lab Question.

MORE *SENSE OF SIGHT* ACTIVITIES

- What is "dark adaptation?"   How does it work and why is it important?

- Do some animals have higher acuity—sharper vision—than we do? What gives them this sharp vision? How do they make use of it?

- Some mammals have eyes toward the sides of their heads (horses, deer) and some have them in front (dogs, cats, lions). What advantages does each group have for its own "lifestyle?"

- What are some eye problems that people have? Try looking for some of the following terms in your library or on the World Wide Web:

  - Glaucoma
  - Corneal transplants
  - Macular degeneration

- Myopia
- Hyperopia
- Astigmatism
- Presbyopia
- Cataracts
- Eye safety
- Detached retina
- Retinitis pigmentosa
- Diabetic retinopathy
- Strabismus

Here are some good **Web sites** to visit for visual system information: help your students find the ones most useful for their projects.

http://www.nei.nih.gov/pubpat.htm

Information on eye diseases, a glossary of vision terms, a school program including information on eye safety and refractive errors

http://faculty.washington.edu/chudler/chvision.html

http://faculty.washington.edu/chudler/bigeye.html

http://faculty.washington.edu/chudler/retina.html

These sites are right here at Neurosciences for Kids and contain information on the anatomy and physiology of vision plus interesting activities

http://www.accessexcellence.org/AE/AEC/CC/vision_background.html

Eye anatomy and function, some too detailed for middle schoolers; go to the Activities section for more ideas

http://www.prevent-blindness.org

Eye problems, diseases, safety

http://www.insight.med.utah.edu/Webvision/index.html

Parts I and VIII are probably most useful, others are for advanced students. Beautiful diagrams, interesting facts and figures, what an opthamologist sees when looking at your retina

http://www-cgi.cnn.com/TECH/9511/new_braille/index.html

Article about a blind physicist creating a new Braille method

http://www.sfn.org/briefings/eye_repair.html

Retinitis pigmentosa, a genetic disease that affects 50,000 to 100,000 people in the U.S.

http://whyfiles.news.wisc.edu/003eye/statistics.html

Statistics on eye disease

http://ericir.syr.edu/Projects/Newton/14/humaneye01.html

Vision background and activities

http://www.exploratorium.edu/snacks/peripheral_vision.html

Another way to make an instrument to investigate peripheral vision; numbers could be added to the disk to make the experiment quantitative. (The comment that rods are responsible for daytime peripheral vision is mistaken—rods function only in very dim light.)

http://www.hhmi.org/senses/b/b150.htm
Diagram of the visual pathway and links to other vision information

ASSESSMENT QUESTIONS

Below are some sample questions on both the **Neuroscience Content** of this unit and on the **Inquiry Method** of teaching and learning. *Please modify these questions to suit your purposes and class level, and create additional questions of your own.* Point out to students that there is **only one correct answer to each question.**

NEUROSCIENCE CONTENT

1. In order to be read, the image of a printed page must fall onto a person's (a) peripheral retina (b) blind spot (c) fovea (d) lens (e) optic nerve

2. Peripheral vision helps us to see well in order to do **all but one** of the following: (a) identify the color of an object b) notice movement to our sides (c) turn and focus on potential dangers (d) play sports (e) drive a car

3. Cone photoreceptors are used for **all but one** of the following functions: (a) seeing colors (b) reading (c) watching movies (d) seeing stars (e) looking at black and white photographs

4. Which one of the following **can** be corrected with prescription eye glasses: (a) night blindness (b) nearsightedness (c) glaucoma (d) blind spot (e) detached retina

5. Animals with eyes on the sides of their heads **do not have one** of the following: a) peripheral vision b) cones c) ciliary muscles d) visual cortex. e) binocular vision

6. The retina develops in the embryo as an outgrowth of the (a) ventricles (b) optic nerve (c) brain (d) skin (e) cornea

7. **All but one** of the following are true of rod photoreceptors: (a) are used for daytime black and white vision (b) are used only in dim light (c) outnumber cones 20 to 1 (d) contain rhodopsin (e) must adapt to dark conditions

8. Messages from the eye travel to the visual cortex, which is located in the (a) frontal lobe (b) medulla (c) lateral geniculate nucleus (d) parietal lobe (e) occipital lobe

KEY FOR NEUROSCIENCE CONTENT QUESTIONS

1. (c)	5. (e)
2. (a)	6. (c)
3. (d)	7. (a)
4. (b)	8. (e)

INQUIRY METHOD

1. A good plan for an experiment does **not** include a (a) prediction (b) written summary of your textbook information on the subject (c) variable (d) list of supplies (e) test for the prediction

2. Which **one** of the following is the **most specific** lab question and will therefore be easiest to test? (a) Why do we see colors? (b) Do animals have color vision? (c) If I stare at a colored circle and then at a white background, what will I see? (d) How is color vision helpful? (e) Is seeing colors more important than seeing black and white?

3. **All but one** of the following procedures are safe laboratory practices: (a) make sure a fire extinguisher is available (b) in general, wear goggles (c) clean up your area when you finish (d) ask for help when using equipment you are not familiar with (e) when in doubt about a chemical substance, smell, feel, or taste it to help with identification

4. Which **one** of the following tools would be most useful in determining if a person has good vision, that is, 20/20 vision? (a) EEG (electroencephalogram) (b) series of colored solutions in glass containers (c) vision disk for measuring peripheral vision (d) standard eye chart (e) microscope

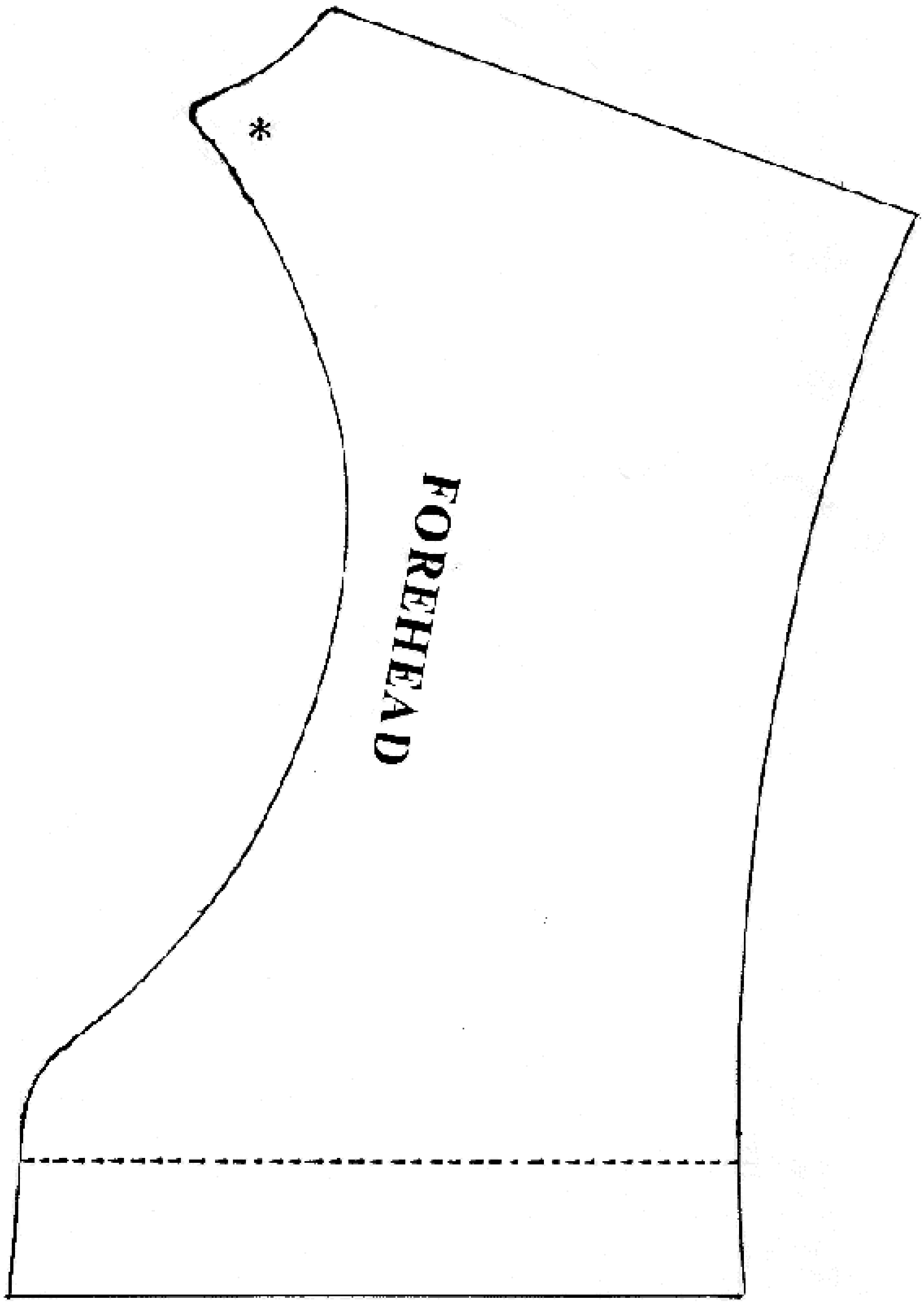
5. You have just conducted an experiment where you made a prediction, tested your prediction and gathered data. Your next step is to (a) analyze your findings (b) consult a textbook to see if your data are correct (c) set up for another experiment (d) draw conclusions (e) turn in the information to the teacher—the experiment is completed

6. A good plan for an experimental procedure includes **one** of the following: (a) a bibliography (b) control system (c) survey of class members for opinions on the procedures (d) phone numbers of chemical supply companies (e) literature review

7. You are a neuroscientist who has landed on a distant planet and discovered an animal unlike any you have seen on Earth. You wonder if the creature can sense light. What is **one** appropriate and simple test you could perform to begin to answer this question? (a) grind up some of the animal's organs and analyze it to see if the photopigment rhodopsin is present (b) kill the animal and search for organs that look like eyes (c) direct a beam of gamma rays at the creature and watch for a response (d) train the animal to go to a specific color to get a reward (e) place the creature in a small familiar environment with one half light and one half dark and see if it consistently goes to one or the other.

KEY FOR INQUIRY METHOD QUESTIONS

1. b; 2. c; 3. e; 4. d; 5. a; 6. b; 7. e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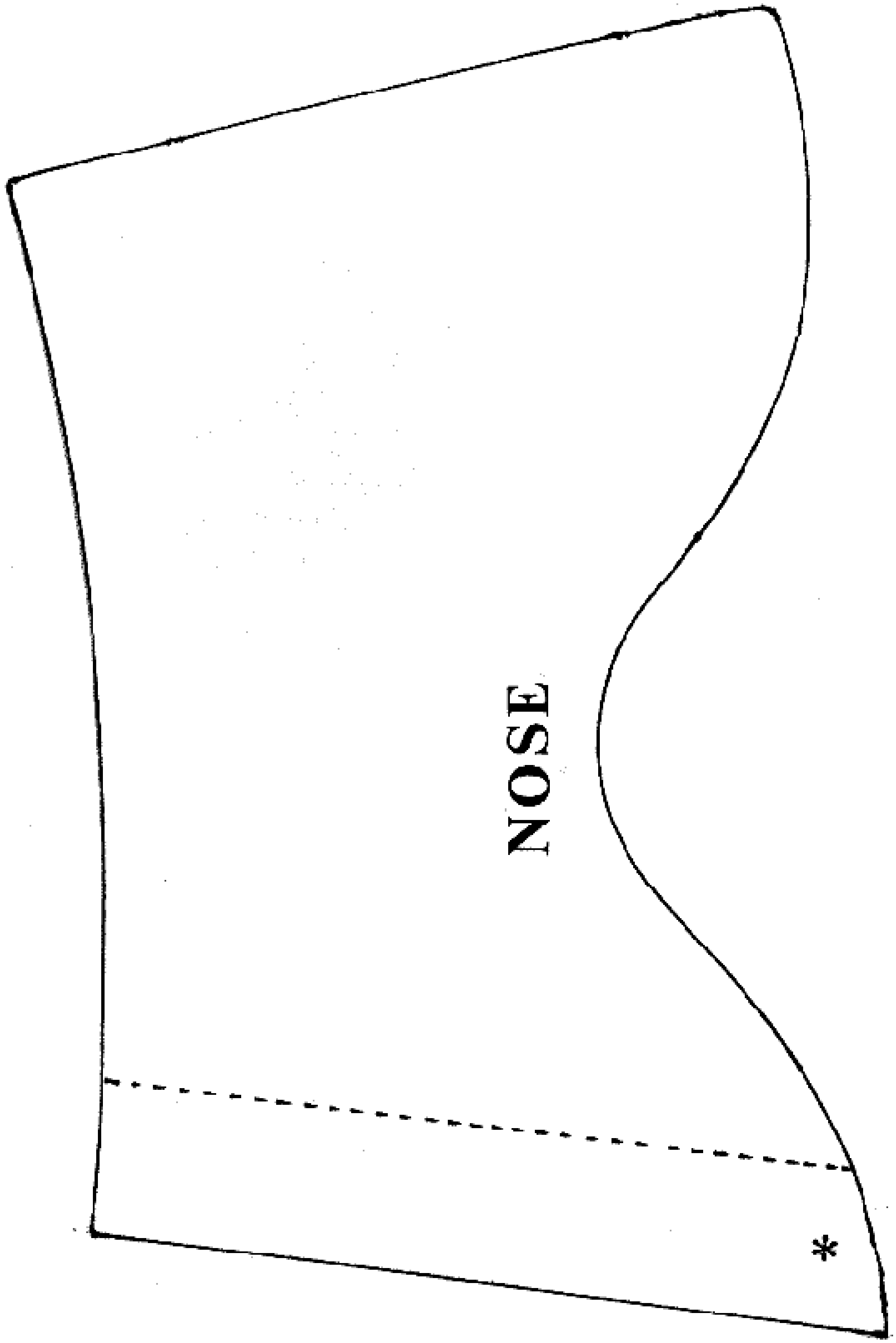
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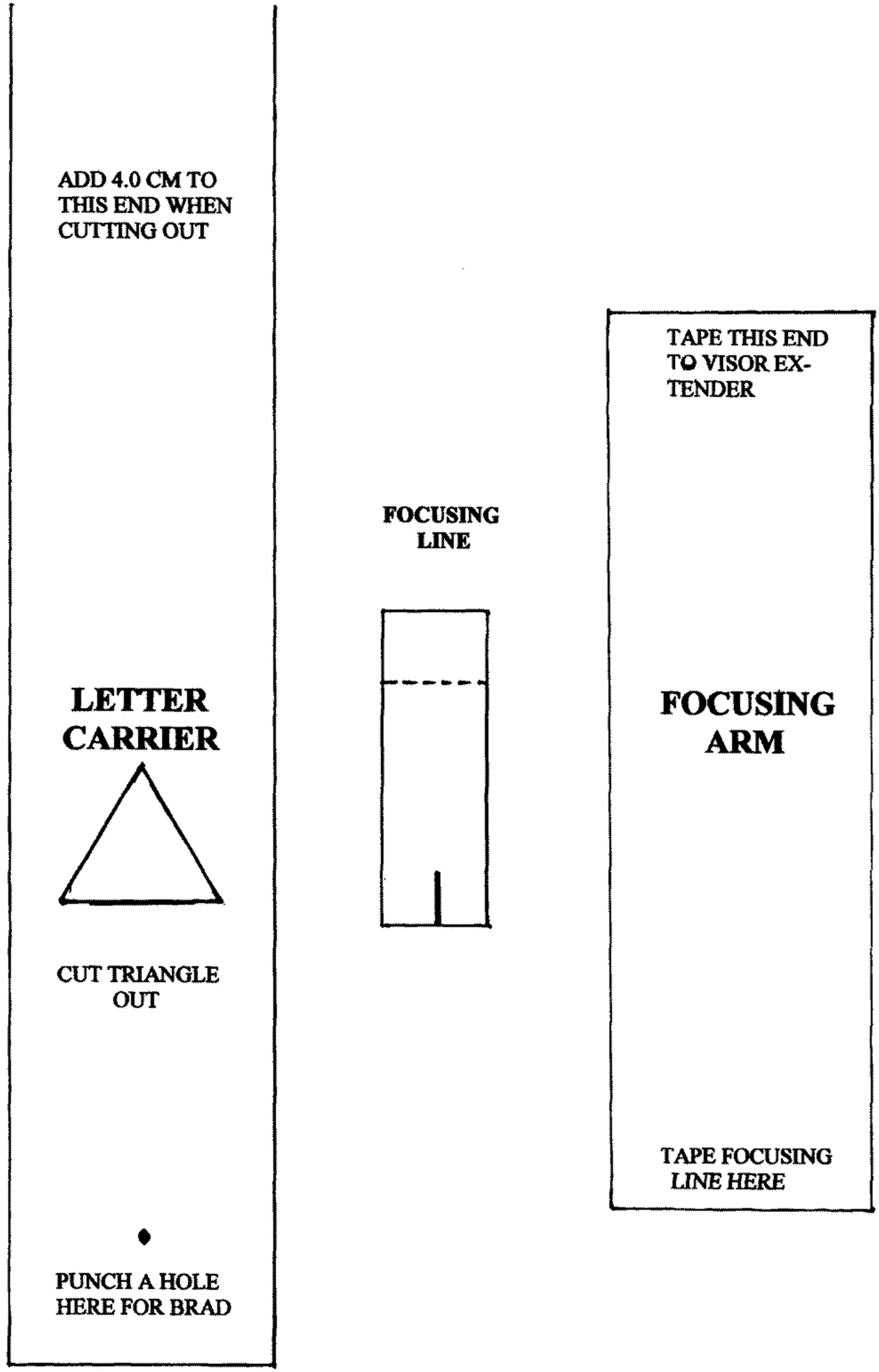
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LETTER CARRIER
CUT TRIANGLE OUT
PUNCH A HOLE HERE FOR BRAD
FOCUSING LINE
TAPE THIS END TO VISOR EX-TENDER
FOCUSING ARM
TAPE FOCUSING LINE HERE