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## A Beginning Education in the Anatomy and Function of the Human Visual Apparatus for Grades 2-4

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**A Beginning Education in the Anatomy and Function of the Human  
Visual Apparatus for Grades 2-4**

Evan S. Andrews  
December 7<sup>th</sup>, 2012

**Lee Honors College, Western Michigan University**

## **Statement of Objectives**

Human beings as a species rely primarily on vision and images to understand and interpret their surroundings. It is a surprise then, that the visual apparatus, while extensively studied, is still a mystery to many in the general population. With such a complicated subject, though, it is best to introduce it early. The primary aim of this project is to give a general understanding of the eye, its anatomy, and its relationship with the brain. This immediate objective will hopefully further the longer term goals of fostering vision safety and an interest in biological sciences.

According to a 2009 Nielsen Company study, the “typical American consumes almost 35 hrs of TV, 2 hrs of time-shifted TV, 4 hrs of internet, 22 minutes of online video and 4 minutes of mobile video” a week, or about 18.5 hours of screen time a day. When coupled UV levels that have “increased markedly over the last three decades,” (Voiland, 2010) the risk factors become fairly apparent. While it has historically been a fairly simple task to maintain eye health day-to-day (wearing UV lenses outside, staying hydrated, etc.), the advancement of the digital age and its ubiquitous industrialization is steadily raising the stakes for the younger generations. With increased exposure to loud media and the threat of significant hearing loss among the general population (Vogel et al, 2008), maintaining the other senses is paramount. Poor eye health and its effects on productivity, even general quality of life, should be brought up as a danger while children are still young in order to promote healthy habits. Some basic education early on could act as a metaphorical pound of cure, preventing a great deal of eye strain and other issues related with visual terminals later on in life (Bergqvist & Knave, 1994).

In the United States there has been a significant decline in scientific interest among elementary-age students continuing into middle school and beyond (Ramey-Gassert, 1997). It has been hypothesized by many educators that an approach containing novelty and hands-on activity can help to stimulate a lasting interest in the sciences and create a new generation of researchers (Ornstein, 2006). For this target audience of grades 2-4, a guest speaker is exciting and can engage students in a way outside of normal schooling. This makes the perfect environment for introducing a challenging topic, like the eye, and sets the scene for further questions and investigation. The inclusion of interactive activities and take-home materials should amplify this effect.

## **The Fundamental Anatomy and Physiology of the Human Eye**

**Subject:** An overview of the parts of the eye and their functions.

**Audience:** Students grades 2-4.

**Brief Description of material:** Students learn about the gross anatomy of the eye and how it interacts with the nervous system to produce and interpret images.

### **Objectives:**

By the end of the lesson students will have a basic understanding of

- The major constituents of the eye and vision apparatus.
- The flow of optical information from light source to brain and its refractive steps.
- Ways the brain can alter an image in its interpretation.

The long term goals of this lesson are to promote interest in the biological sciences and healthy vision habits.

### **Materials Required:**

- Eye anatomy work sheet, one for each student.
- Blind spot test strip, one for each student.
- Color blindness testing charts.
- Anatomical model of the eye.

### **Lesson Plan and Order of Instruction:**

**(Note: This was written originally as a guest lecture but may be easily adapted)**

- Introduce yourself and the topic of the eye. Quickly assess the students' familiarity with subjects in the presentation. This will be fairly low level and will probably consist mainly of some students who have corrective lenses and what they have been told by their doctors.
- Pass out the eye anatomy worksheet to each student. Present the two views of the eye on the worksheet giving a very quick mention of why the section view is useful.
- It is best if the instructor's copy is projected so that the students can follow along. Biological terms are easy to misspell and it may also be good to supplement the visual reminder by spelling each term out loud.

### **Anatomy**

- Begin with item eight (8) and the front view on the lower half of the page. This is a more familiar image to the students and uses terms they may have heard before. The familiarity should help them ease in to the more difficult material and facilitate explaining later concepts.
- Explain each component of the eye after labeling them on the sheet.
  1. Eyelid: A flap of skin that helps protect the eye and spreads a renewed tear layer The tear layer is required for proper eye health and so blinking developed as a reflex.
  2. Pupil: A hole in the front of the eye of variable size that allows light to enter.
  3. Iris: A collection of pigmented muscle surrounding the pupil. The muscle changes the size of the pupil while the pigments prevent unwanted light from entering through the fibers.

**The remaining entries use the section view and contain some repeated terms.**

1. Cornea: A thin, transparent layer that protects the pupil. (Depending on the age of the students the instructor may or may not want to mention the cornea's refractive function.)
  2. Pupil (see above)
  3. Iris (see above; use the alternate view to further explain the structure if needed)
  4. Lens: Explain the lens using the following points
    - Structure: A clear, dense body of specific shape (this may be easier to come back to when examining the 3D model).
    - Refraction: Quickly define refraction (the bending of light) and how the lens focuses light. Mention the difference between refraction and reflection.
    - Correction: Illustrate on the projected worksheet how sometimes light is not focused on the right spot and this is why some people have corrective lenses. Compare to moving a magnifying glass in and out.
  5. Eyelid (see above)
  6. Optic Nerve (or Nerve): A thick fiber (comparison to rope or cord may be help comprehension) that carries information from the eye to the brain. It is recommended that the nerve be briefly revisited after introducing the retina.
  7. Retina: The material covering inside the back of the eye that turns light into image information. It is full of specialized units called rods and cones (these will be covered later on).
- Bring out the 3D eye model.
    1. Explain the purpose of the orbit and how the skull is needed to protect the sensitive eye. This may be skipped if the model does not have any bone attached.
    2. Indicate the skeletal muscle attached to the eye or describe them if the model does not have musculature.
    3. Show the location of the lacrimal (tear) gland on the upper left area of the eye from the students' perspective.
    4. Make sure to show where the nerve connects as this will be important in a later activity.
    5. Disassemble the eye model, showing the individual parts to the students. Make sure to show: pupil, iris, cornea, lens, ciliary muscles, and retina.
      - Now is a good time to introduce subjects like laser eye surgery and cataracts as the cornea and lens are being displayed. It will make more sense to the students when there is a physical object to attach the concept to. It is advisable not to spend too much time on this, though.
      - If the retina is shown last then it is easier to segue into the next topic.

#### White Point and Color

- Talk about the “white point” and how it can be changed by different types of light. Compare what the inside of the school or their home looks like after being inside and just after being outside. For the first few minutes after coming back inside things look strange because the brain has a different type of light (5200K sunlight versus fluorescents or 3200K incandescents) as “white.” If there is an incandescent lamp available show how the light looks orange/amber.
- Discuss how cones are divided into groups that recognize red, green, and blue light,

producing color images.

- Describe how issues with one or more sets of cones can produce color blindness and show the students a few color blindness test images.

### Optical Illusions

- Return to the projector and put up the first optical illusion (the black squares around white circles). Ask the students how many black circles they see then describe how the illusion works.
  1. There are no black circles, only white ones. The surrounding areas of black and grey are averaged with the white circles by the brain in all but the area being focused on. This gives the appearance of grey-filled circles.
  2. **Note:** This illusion may be somewhat ineffective depending on the projector used.
  3. Put the second illusion on the projector (the “white triangle”). Ask the students if they see a white triangle and then describe how the illusion works. Some students may also describe a black-rimmed triangle underneath the white one.
    - The human brain is constantly combining and averaging the images it receives, resulting in a phenomenon called the Law of Closure. The brain is combining what it perceives as pieces of an object into a complete one (a single or pair of triangles).
  4. Explain that there is a reason for all of the combination and averaging to segue into the next exercise.

### The Blindspot

- Return to model and lead the students into realizing that there cannot be rods and cones where the nerve connects to the retina, thus no image is perceived at that point. Explain that the blind spot goes unnoticed because overlapping information is coming from both eyes. Tell the students that the blind spot can be seen, leading to the next activity.

Blind spot activity (symbols may change depending on what strips are used):

1. Hold the paper strip so that the “+” is directly in front of one eye and the remainder is toward the outside of your field of vision.
2. Cover the other eye with your hand.
3. While staring directly at the “+”, move the strip closer and farther from the open eye until the “X” disappears and there is a continuous line. The point in space where the “X” lies within the blind spot of that eye.

### Closing

At the end of the lesson briefly summarize the material.

- Have the students list off the parts of the eye
- Ask one or two volunteers for a fact about color and how it is perceived
- Have a volunteer explain why there is a blind spot and how this is overcome

Use any remaining time to take questions.

**Useful definitions:**

Anatomy: The shape and structure of a living thing or its parts.

Refraction: The bending of light through a medium.

Color blindness: The inability to perceive certain wavelengths of visible light; usually from an issue in retina development.

Cones: Specialized cells in the retina that can detect specific wavelengths of light.

Rods: Specialized cells in the retina that detect low intensity light.

Law of Closure: The unconscious tendency to ignore gaps in images or perceive incomplete/fragmented objects as complete.

## Personal Reflection

The eye and visual system has fascinated me from the time that I was very young. To me it was something so fascinating, so elegant, that it was almost beyond belief; unfortunately, it was also out of reach. The scant few resources on the subject available for children were not enough to point me in the right direction and nothing in the day-to-day at school came close. The frustration grew when I first began wearing glasses and was unable to really understand why. Later schooling and the advent of rapidly available free information came to solve this issue but the earlier dissatisfaction remained in memory, even if it was one of the driving forces behind my interest in science. This project was conceived so that others would have an introduction to the amazing visual apparatus—including relevant safety concerns—without the irritation. It is my hope that by framing concepts in a fun and interactive way that I was able to interest at least a few students in the sciences.

All three presentations were given at Arcadia Elementary in Kalamazoo, MI. Two third-grade classes and one second-grade class participated; the recording uses segments from the first third-grade and second-grade groups. The teacher of the second-grade class, Debra Gant, was a former instructor of mine and was instrumental to the preparation for this project. Aside from nostalgia and the desire to give back to a former school, Arcadia was also chosen because of the increasing focus on the sciences in its curriculum.

Overall I consider this project a success. The students were attentive for the entirety of all three presentations despite some small difficulty with the material. The lesson plan seemed to flow well with the students and there was no shortage of questions, comments, and volunteered answers, indicating a reasonable degree of understanding. The use of a 3D model seemed especially helpful to understanding the anatomy of the eye and having something tangible to take with them (the blind spot test) really ended the lesson on a high note. I was able to discuss the lesson with all three teachers later the same day and all remarked that the students had a very positive response.

As a side note, the number of students who participated was very surprising; at least half of the students in each class actively participated in some way during the presentation, far more than was expected. The amount of information that some of the students already possessed was also astounding in some cases (e.g. the girl heard in the recorded presentation referencing the cornea).

Aside from one or two misstated facts, the only part of the presentation that gave any difficulty was the section on color blindness. While I did not encounter any students who were sensitive about the subject the possibility remains that the topic could be upsetting to some, especially if they were unaware of the condition before then. It is also somewhat difficult to properly present the topic as most available projectors wash out the colors, rendering the test ineffective. This problem is minor, though, as the lecture portion of the topic still seemed to convey sufficient information. Technical difficulties kept this part of the presentation off of the video recording, unfortunately, so a more thorough analysis is difficult.

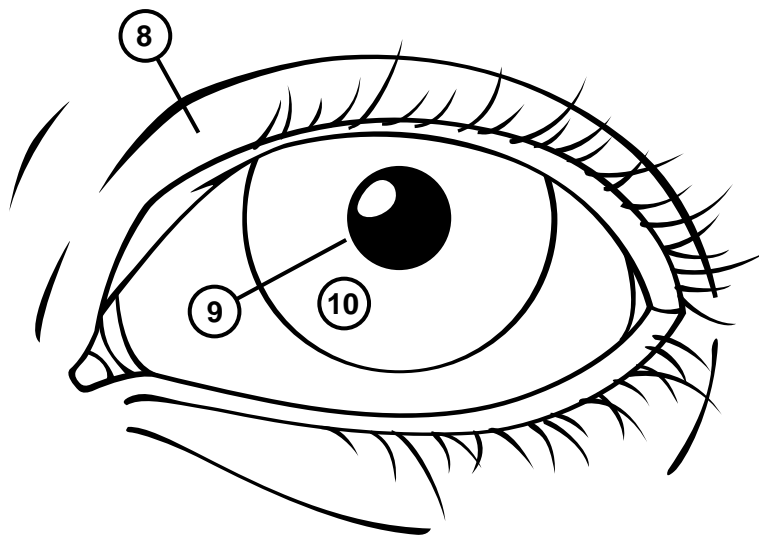
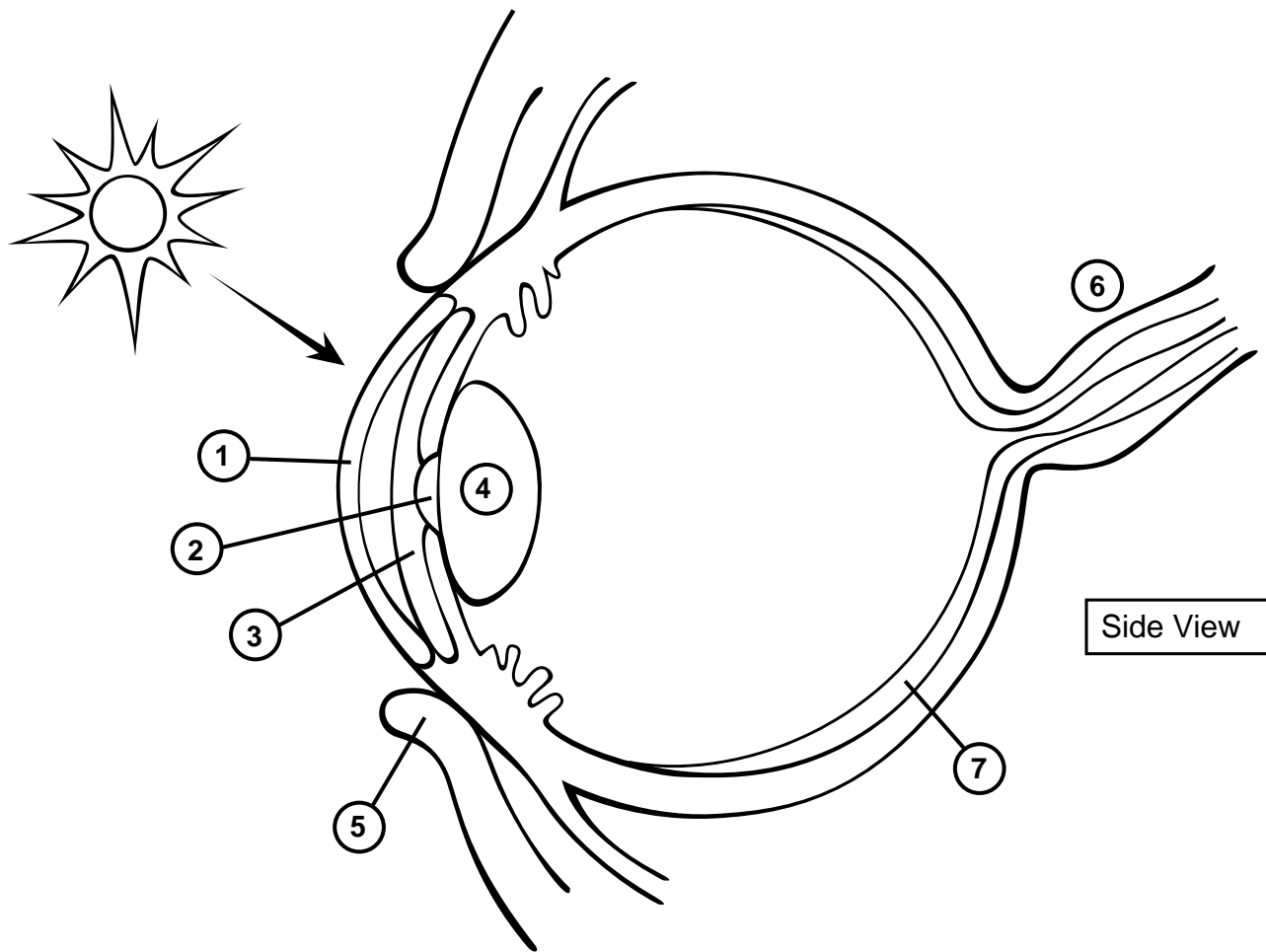


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## Visual Resources Used

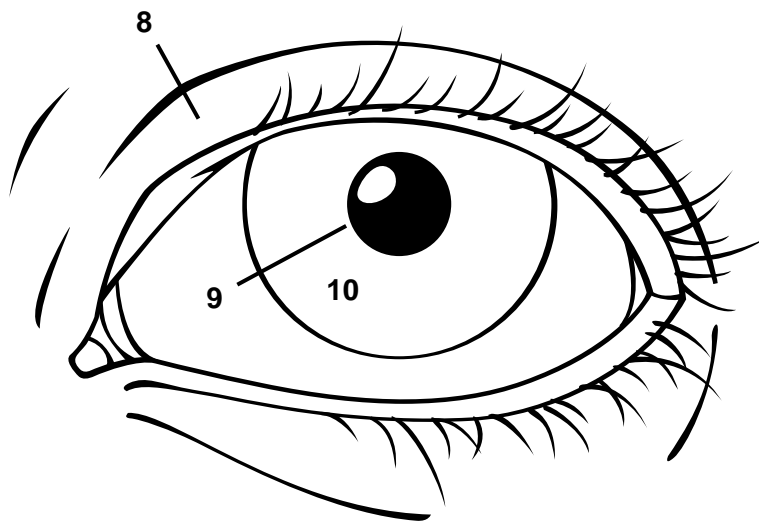
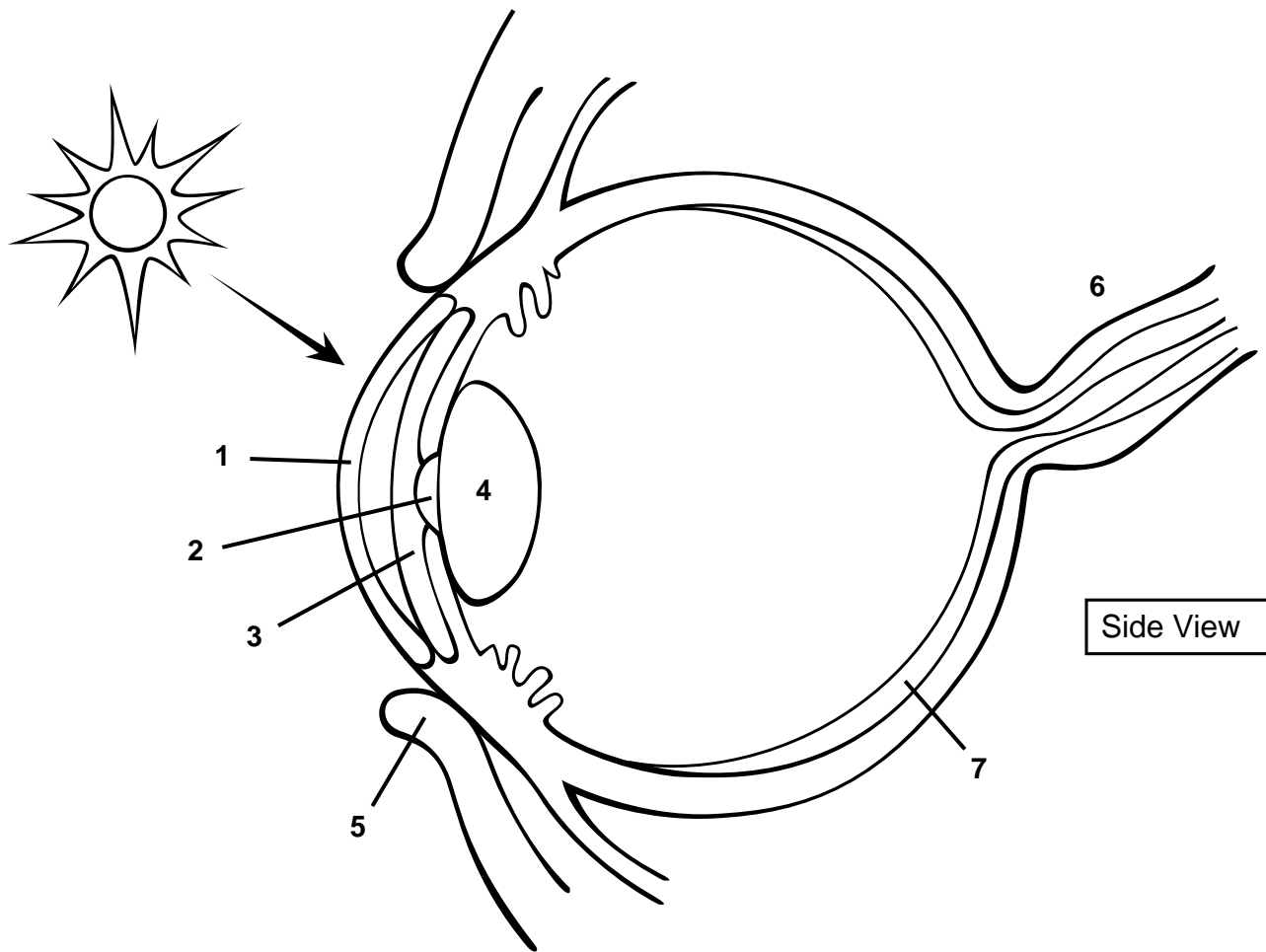
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1 Cornea  
 2 Pupil  
 3 Iris  
 4 Lens

5 Eyelid  
 6 Optical Nerve  
 7 Retina  
 8 Eyelid

9 Pupil  
 10 Iris

