

TxCETP Course Component:

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## **I. Introduction**

### **Subject Area:**

Biology: Anatomy and Physiology of the Human Eye.

### **Topic:**

Modeling the human eye to discover its function, defects, and correction through simple physics.

### **Grade Level:**

7-12.

### **Objectives:**

- Students will be able to:
  - a. identify the following structural features of the human eye using diagrams, models, and/or dissected specimens: cornea, pupil, iris, aqueous humor, lens, retina, and central fovea and the relationships of these structures to the ciliary muscle and suspensory ligaments, rods, and cones;
  - b. list/trace the pathway of structures encountered by light rays from the environment to the retina;
  - c. recognize the structural differences between human eyes representing the following typical conditions of vision: normal (emmetropia), far-sighted (hypermetropia), near-sighted (myopia), astigmatism and 'old age' vision (presbyopia), effects of lens removal as in cataract surgery, and combinations of these conditions in the same eye;
  - d. use the scientific method to demonstrate the basic means by which visual defects are diagnosed and corrected with ground glass lenses;
  - e. list the basic sequence of steps and anatomical structures involved in the transduction of light energy entering the eye to perception of an object;
  - f. define the terms *near point of accommodation* and *presbyopia*, list the main causes and demonstrate or use a simple test to illustrate the differences in *near point of accommodation* between individuals of various ages, and explain the findings to the subject of the test.
- Students will be able to administer simple basic visual acuity tests to one another and be able to correlate their performance with standards for visual acuity assessment, and the type of visual defect detected (if any).
- Given a set of scenarios which describe initial findings made above, students will be able to predict the specific type of lens required in spectacles to provide vision correction.

## **TxCETP Course Component: The Working Human Eye**

This material is based on work supported by the National Science Foundation under Grant No. DUE 9987332.

### **Teaching Method:**

The group of activities described here is intended to provide a fun alternative to the more traditional methods of strict fact-based “lecture and memory recall” class presentation. It is presumed that there be a certain amount of basic knowledge and understanding in the subject area students should possess before beginning the group of activities. Although the methods used here employ techniques in guided discovery and problem based learning (as well as inquiry-based learning), the importance of establishing a strong background in working terminology and a solid understanding of the basic concepts to be addressed within must be stressed. Students inadequately prepared to pursue this approach and relatively naïve to the way it operates will probably experience at least some degree of real frustration. Indeed, for many students, it will seem as though the teacher is abandoning them at some point in the process. Also, for the teacher relatively new to using this method of teaching, it may be quite uncomfortable having to resist the natural urge all good teachers have to come to the students’ rescue when it is quite obvious that they are struggling to make the necessary connections. The best way to avoid these situations is to make every effort to arm the students with:

- (i) a working knowledge of the subject(s) that will be applied,
- (ii) a familiarity with the resources they have at hand for retrieving the information they will need to problem solve and apply what they are learning, and
- (iii) support their work and encourage true discovery which doesn’t always produce “one correct answer” but allows the student to learn by trial and error.

And, after all, isn’t this the way the scientific method is supposed to work? Formulate a hypothesis, design an experiment to test it, collect the data, and then evaluate the results to decide if they support the hypothesis or not. To this end, a checklist of pre-requisite knowledge and skills is offered here.

### **Prerequisite Knowledge and Skills:**

It is anticipated that the teacher using these activities in the classroom or the laboratory will have made class presentations and/or outside reading assignments or reports which address them. A list of references which can be used as a resource for additional teacher preparation is included in the bibliography section of this document. These references can also provide a resource for teachers wishing to expand on the content coverage here and develop additional activities of their own. Students should have the following:

- A working definition of the following technical terms: light ray, refraction, focal point, focal distance, lens, convergent, divergent, convex, concave, spherical, cylindrical, and optical.
- The ability to label a diagram/drawing which represents a view of the internal and external anatomy of the eye with the following components: sclera, choroid, retina, cornea, iris, ciliary muscle, suspensory ligaments, (crystalline) lens, pupil, central fovea, optic disk / blind spot, optic nerve.
- The understanding and ability to apply the scientific method to problem solving.

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#### **Materials: (per working group of no more than 4 students each)**

- Ingersoll Eye Model Kit (available from CENCO/VWR Scientific, 1.800.932.5000) Cat# CP 87660-00  
*This kit contains all of the materials needed for this activity requiring optical lenses and a previously constructed eye model. It is certainly possible for instructors to acquire equivalent materials from alternate sources. Some teachers may even wish to acquire suitable materials and have their students assemble them as a manipulative exercise in learning the anatomy of the eye as well. However, in the interest of time and sustaining equipment which has proven itself to be both reliable and very durable, this particular kit has proven itself time and time again. (Images of this equipment are included in this activity posting.)*
- Eye Model Tank with fixed 'cornea' lens
- 'Retina' with designated visual field and central fovea areas
- Patterned object light box with image screen and light bulb (40 W max recommended)
- Lens box containing each of the following lenses:
  - iris diaphragm
  - + 20.00 diopter double convex convergent
  - + 7.00 diopter plano-convex convergent
  - + 2.00 diopter spherical convex convergent
  - + 1.75 diopter cylindrical convex convergent
  - 5.50 diopter cylindrical concave divergent
  - 1.75 diopter spherical concave divergent
- Eye Anatomy Charts/Figures/Diagrams/Models etc.
- Snellen (Vision) Test Chart(s) to be posted in classroom (See VWR Scientific Catalogue item # WL3539A or WL3539, the later chart also bears the grid used to offer a simple test for astigmatism suitable for this activity)
- Meter/Yard Stick (if one wanted to also apply conversions of metric/English either of these could be used)
- 6 inch / 6 centimeter ruler
- 1 roll ½ inch masking tape
- Fine tip (Sharpie) Marking Pen
- Flashlight (optional, but helpful when students are attempting to find objects, read/write etc., during the period of darkness in the room this activity requires)
- Water
- Eosin dye (optional)
- Chalk & chalkboard / dry erase marker and wallboard / overhead projector and blank acetate transparency, etc.
- Handouts of eye anatomy
- Blank 3x5" index cards
- Lens paper (optical grade for cleaning lenses)
- Vaseline / petroleum jelly / stopcock grease (oil-based lubricant)
- Dishwashing detergent or hand soap
- Paper towels

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#### **Estimated Time Required:**

Three to 3.5 hours to be extended over 2 to 4 sessions.

#### **Activities:**

- Perform a standard visual acuity test on classmate volunteers.
  - Pair quiz which assesses student pre-knowledge of eye anatomy and the functions of its basic components.
  - “Fastest finger” group competition to track the path of light rays through the eye (with *PRIZES!*).
  - Arrange a group of cards representing the flow of nerve impulses from the eye to a visual perception in the brain.
  - Use the materials available to assemble/construct a real working model of an eye with:
    - a. normal vision (emmetropia)
    - b. hyperopia (far-sighted)
    - c. myopia (near-sighted)
    - d. astigmatism
    - e. a compound defect such as near-sighted with astigmatism and cataract, etc.
- Use the scientific method and the materials available to design experiments that will demonstrate the appropriate means for correcting each of the visual defects using available lenses.
- Perform a test to determine near point of accommodation and model this condition in the materials available.