Aniridia: An Eye Disease

A husband and wife are expecting a baby. They hope their baby will be healthy. One reason they are concerned is that the father has the disease aniridia (pronounced "an-eye-rid-ee-ah"). A person with aniridia is missing part of the iris, or colored part of the eye. The husband's mother, who is the baby's grandmother, also has the disease.

During a doctor visit, the parents ask what is known about the disease. The doctor tells them that aniridia is a rare disease. Worldwide, it occurs in 1 out of 50,000–100,000 newborns. In addition to missing part of the colored part of the eye, people with aniridia often have pupils that are misshapen or abnormal. They may also have other eye problems, such as glaucoma (increased pressure in the eye), cataracts (clouding of the lens of the eye), or abnormalities in the optic nerve. Most people with aniridia have poor vision. Sometimes, special glasses, medications, or surgery can help, but individuals with aniridia run the risk of losing their eyesight.

Questions

1. Do you think the parents' concern for their baby's health is justified? Why?

2. From the information provided, would you expect aniridia to be caused by an infection, an environmental factor, or a genetic factor? Explain your answer.

Learning about Human Health from Other Organisms

Name: _____

For each part on this handout, you will analyze a different type of data about the *Pax6* gene.

Part 1: Comparing Amino Acid Sequences

Scientists have purified the protein coded by the *Pax6* gene in humans and other organisms. Look at the sequences of amino acids that make up a portion of the protein from four different species* and answer the questions that follow. Each letter in the sequence represents one amino acid in the protein.

Figure 1. *Amino acids for a portion of the Pax6 protein from humans, mice, zebrafish, and fruit flies.*

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Human:       LQRNRTSFTQEQIEALEKEFERTHYPDVFARERLAAKIDLPEARIQVWFSNRRAKWRREE
Mouse:       LQRNRTSFTQEQIEALEKEFERTHYPDVFARERLAAKIDLPEARIQVWFSNRRAKWRREE
Zebrafish:   LQRNRTSFTQEQIEALEKEFERTHYPDVFARERLAAKIDLPEARIQVWFSNRRAKWRREE
Fruit fly:   LQRNRTSFTNDQIDSLEKEFERTHYPDVFARERLAGKIGLPEARIQVWFSNRRAKWRREE
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Questions

1. What do you notice about the amino acid sequences in the different species?

2. What can you infer about the *Pax6* gene from the protein sequences from these four species?

Part 2: What Happens If *Pax6* Does Not Function Normally?

One way that scientists study the function of genes is to find out what happens when the gene is not functioning normally. In other words, what happens if there is a mutation in the gene that affects its function? Use the pictures your teacher will show to answer the following question.

Question

3. On the basis of the pictures, do you think the function of the *Pax6* gene is similar in all four species? Explain your reasoning.

Part 3: Further Comparing Genes across Species

Scientists now have the ability to isolate DNA sequences that contain the genes they are interested in studying. In some cases, scientists can also insert the genes from one species into another species. The results tell researchers whether the gene functions similarly in the two different species.

Scientists have isolated the *Pax6* gene from a variety of animals, including squid, fruit flies, zebrafish, and mice. Scientists know that fruit flies that have two mutant copies of the *Pax6* gene do not have eyes. When scientists inserted the DNA sequence for the squid *Pax6* gene into these fruit flies, the flies developed eyes. In a second experiment, scientists inserted the DNA sequence for the mouse *Pax6* gene into the fruit flies with two mutant *Pax6* genes. The flies developed eyes in this case, too.

Question

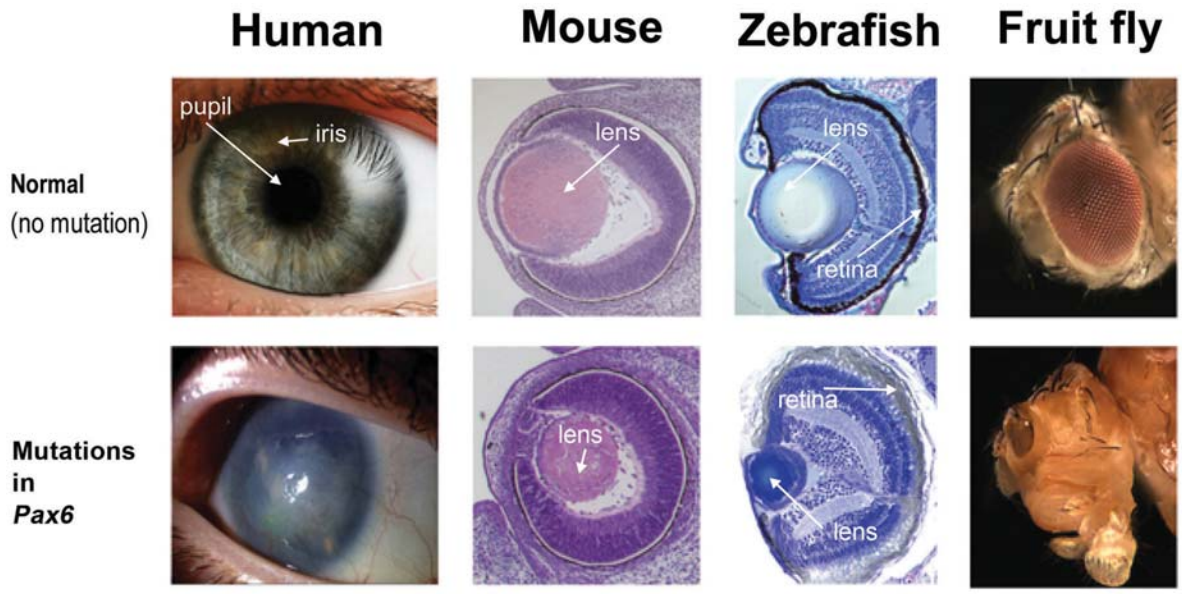
4. What do these experiments suggest about the function of the *Pax6* gene? Explain your thinking.

Summary Question

5. In the sequence data, you saw that the protein coded by the *Pax6* gene is very similar in fruit flies, zebrafish, mice, and humans. In the other experiments, you examined evidence related to the gene's function. Why might many species have almost exactly the same gene that has a similar function?

*Sequences for the fruit fly, mouse, and human are from here: S. Carroll. 2006. *The Making of the Fittest*. New York: W. W. Norton. The zebrafish sequence was downloaded from GenBank, http://www.ncbi.nlm.nih.gov/genbank/.

Photographs of Normal Eyes and Eyes with *Pax6* Mutations

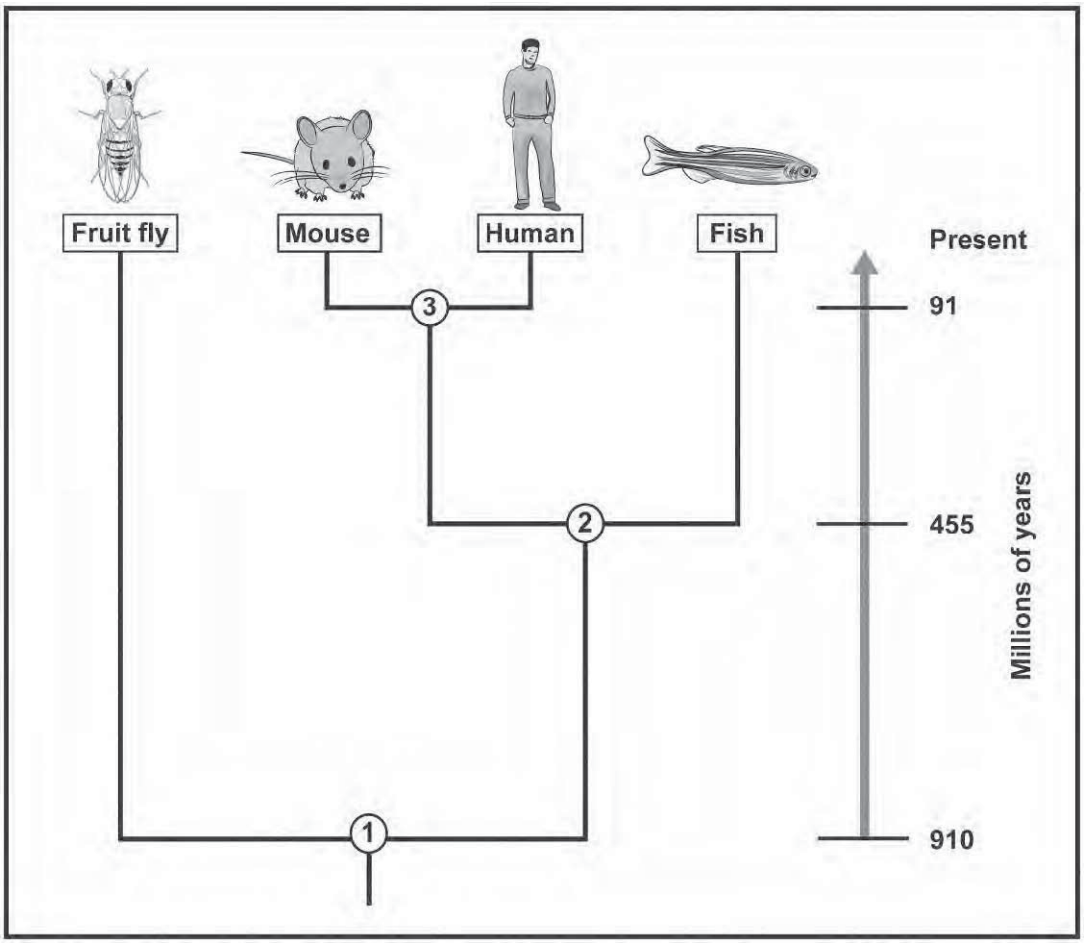


Phenotype with *Pax6* mutation	Opaque cornea Iris absent Degenerated retina Opaque lens Pressure on eyeball	Eye small Lens fused to cornea Iris anatomy changed Other eye abnormalities	Eye small Lens small Retina malformed	Eye small or absent

Source: Adapted from N.L. Washington et al. 2009. Linking human diseases to animal models using ontology-based phenotype annotation. *PLoS Biology,* 7(11): e1000247. doi:10.1371/journal.pbio.1000247.

An Evolutionary Tree

Name: _____



Questions

1. What part of the evolutionary tree diagram represents the common ancestor of humans, mice, and zebrafish (but not fruit flies)? Why did you identify this part of the diagram?

2. Does the evolutionary tree suggest that the mouse is more closely related to the zebrafish or the fruit fly?

3. Is the fruit fly the ancestor of all the other species on the evolutionary tree? Explain your answer.

4. What does the vertical line beneath Point 1 represent?