

# Albino Redwoods Educator Guide

A resource for using QUEST video, audio and blogs in the classroom

## QUEST SUBJECTS

<p><b>Life Science</b></p> <p><b>Earth Science</b></p> <p><b>Physical Science</b></p>	<p><b>Biology</b> Health Environment</p> <p>Geology Climate Weather Astronomy</p> <p>Physics Chemistry Engineering</p>
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## CA SCIENCE STANDARDS

**Grade 5**  
*Life Sciences*  
2. (f, g) Plants use carbon dioxide and energy from sunlight to build molecules of sugar and release oxygen; Plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide and water (respiration).

**Grade 7**  
*Cell Biology (Focus on Life Sciences)*  
1. (d) Mitochondria liberate energy for the work that cells do and chloroplasts capture sunlight energy for photosynthesis.

*Genetics (Focus on Life Sciences)*  
2. (e) DNA is the genetic material of living organisms and is located in the chromosomes of each cell.

**Grades 9-12**  
*Genetics (Biology)*  
4. (c) Mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

## QUEST MEDIA FOR TEACHING ABOUT ALBINO REDWOODS

Read and comment on the blogs for these stories by clicking on the story link and clicking on the Producer's or Reporter's Notes link under "Additional Links."

Watch "Science on the SPOT: Albino Redwoods, Ghosts of the Forest"  
<http://science.kqed.org/quest/video/science-on-the-spot-albino-redwoods-ghosts-of-the-forest/>

• **QUEST** ventures into the deep canopy of Henry Cowell Redwoods State Park near Felton, California, to track down these elusive phantoms of the forest.

Listen to "Albino Redwoods: Ghosts of the Forest"  
<http://science.kqed.org/quest/audio/albino-redwoods-ghosts-of-the-forest/>

• Park rangers in the Santa Cruz Mountains are protecting a decades-old secret: albino redwood trees. Pale and fragile, these so-called "ghost trees" are deliberately off the beaten track.

Watch "Science on the SPOT: Revisiting Albino Redwoods, Cracking the Code"  
<http://science.kqed.org/quest/video/science-on-the-spot-revisiting-albino-redwoods-cracking-the-code/>

• **QUEST** follows Stanford geneticists as they seek to discover the root of the mutation behind albino redwoods. See how they take samples back to their lab and put them through the genetic ringer to sequence and compare complicated redwood genomes.

Watch "Science on the SPOT: Revisiting Albino Redwoods, Biological Mystery"  
<http://science.kqed.org/quest/video/science-on-the-spot-revisiting-albino-redwoods-biological-mystery/>

• Travel with UC Santa Cruz plant biologist Jarmila Pitterman and her students as they study rare albino redwood trees in the Santa Cruz Mountains.

## TOPIC BACKGROUND

As in animals, albinism in plants is caused by lack of pigment. The pigment missing in an albino tree is the green pigment chlorophyll. In a normal plant, chlorophyll absorbs sunlight to drive photosynthesis. Albino redwoods have creamy white, waxy leaves rather than green ones. Because these ghostly trees can't produce their own food, they grow in such a way that they can steal nutrients. Their ability to survive makes albino redwoods rare among conifers. Only a few dozen or so are known to exist. Those that have been seen in nature are most often found in the darkest parts of old-growth forest regions.

Redwood trees are typically known for their awe-inspiring height. Do you think that albino redwoods can reach the height of a regular redwood tree? Researchers are interested in sequencing the albino redwood genome to understand the molecular cause of this rare breed. Also, by learning how albino redwoods develop and survive, researchers may unlock some of the mysteries of how redwood trees live and how they might weather challenges such as disease, drought and climate change.

### Additional background resources:

NPS: A Quest at Muir Woods <http://www.nps.gov/muwo/forkids/index.htm>

Redwoods Teacher Toolkit <http://education.savetheredwoods.org/kit/index.php>

## VOCABULARY

### Albino

an organism without pigmentation or coloration

### Chlorophyll

green pigments found in the chloroplasts of plants and other photosynthetic organisms

### Chromosome

a threadlike linear strand of DNA and proteins that contains most of an organism's genes

### DNA sequencing

using chemical reactions on small samples of tissue to determine the DNA code

### Genetic mutation

any change in the inherited DNA sequence of an organism

### Photosynthesis

the process of converting sunlight, water and carbon dioxide into oxygen and sugar

### Regenerate

to regrow part of an organ or tissue

### Transpiration

process by which plants pull water up through the roots to other organs such as leaves

## PRE-VIEWING

- What do you know about albinos and albinism?
- How do you think albino redwood trees differ from other redwood trees?

## VIEWING FOCUS

- Describe several ways that albino redwoods differ from other redwoods. Explain these differences.
- What are some physiological and molecular questions that scientists are trying to answer by studying albino redwoods? How do scientists make measurements to address these questions?
- How does a redwood forest demonstrate genetic diversity? How does this phenomenon explain the presence of albino redwoods in a forest yet complicate DNA sequencing efforts?
- Based on what you've learned from these segments, generate some questions of your own about albino redwoods (and how you might test these questions).

*For all media see:*

- Segment Summary Student Sheet  
[http://science.kqed.org/quest/files/imp/QUEST\\_SegSum\\_StudentSheet.pdf](http://science.kqed.org/quest/files/imp/QUEST_SegSum_StudentSheet.pdf)
- Personal Response Student Sheet  
[http://science.kqed.org/quest/files/imp/QUEST\\_PersResp\\_StudentSheet.pdf](http://science.kqed.org/quest/files/imp/QUEST_PersResp_StudentSheet.pdf)

## LESSON PLANS and RESOURCES from QUEST, PBS and NPR

### Redwoods: A Walk Among the Giants NPR

<http://www.npr.org/templates/story/story.php?storyId=1529854>

This December 3, 2003, story from NPR's **Morning Edition** follows reporter Ketzell Levine as she walks among redwood trees in Humboldt Redwoods State Park and the Avenue of the Giants.

### Redwoods at Redwood National Park PBS LearningMedia

<http://www.pbslearningmedia.org/content/etv08.sci.life.oate.redwood/>

Take an exploratory journey through the Redwood National Park to learn all about these amazing trees in this video segment from **NatureScene**.

### Illuminating Photosynthesis PBS LearningMedia

<http://www.pbslearningmedia.org/content/tdc02.sci.life.stru.methusweb/>

This interactive feature from the **NOVA**: "Methuselah Tree" Web site explores the process plants use to convert solar energy into chemical energy.

### DNA Sequencing PBS LearningMedia

<http://www.pbslearningmedia.org/content/biot09.sci.life.gen.dnasequencing/>

In this interactive activity adapted from the Dolan DNA Learning Center, examine the techniques geneticists use to read a sequence of DNA fragments.

### Redwoods Resource Collection QUEST

<http://science.kqed.org/quest/special-coverage/redwoods/>

**QUEST** has many more resources about redwoods in addition to the video and audio pieces listed on the first page of this guide. Watch other videos, go on a science hike and converse with scientists through the **QUEST** blog.

## VISIT OUR PARTNERS

The Bay Institute  
[www.bay.org](http://www.bay.org)

California Academy of Sciences  
[www.calacademy.org](http://www.calacademy.org)

Chabot Space and Science Center  
[www.chabotspace.org](http://www.chabotspace.org)

East Bay Regional Park District  
[www.ebparks.org](http://www.ebparks.org)

Exploratorium  
[www.exploratorium.edu](http://www.exploratorium.edu)

Girl Scouts of Northern California  
[www.girlscoutsnorcal.org](http://www.girlscoutsnorcal.org)

Golden Gate National Parks Conservancy  
[www.parksconservancy.org](http://www.parksconservancy.org)

The J. David Gladstone Institutes  
[www.gladstone.ucsf.edu](http://www.gladstone.ucsf.edu)

Lawrence Berkeley National Laboratory  
[www.lbl.gov](http://www.lbl.gov)

Lawrence Hall of Science  
[www.lawrencehallofscience.org](http://www.lawrencehallofscience.org)

Monterey Bay Aquarium  
[www.mbayaq.org](http://www.mbayaq.org)

Monterey Bay Aquarium Research Institute  
[www.mbari.org](http://www.mbari.org)

Oakland Zoo  
[www.oaklandzoo.org](http://www.oaklandzoo.org)

Stanford University's Woods Institute for the Environment  
<http://woods.stanford.edu>

The Tech Museum of Innovation  
[www.thetech.org](http://www.thetech.org)

UC Berkeley Natural History Museums  
<http://bnhm.berkeley.edu/>

## MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21<sup>st</sup> CENTURY SKILLS IN TEACHING AND LEARNING

### Why Use Multimedia in Science Education?

<http://science.kqed.org/quest/files/downloads/2011/06/QUESTWhyMedia.pdf>

- Read about the importance of using multimedia in the 21st century science classroom.

### How to Use Science Media for Teaching and Learning

<http://science.kqed.org/quest/files/downloads/2011/06/QUESTMediaTips.pdf>

- A collection of tips, activities and handouts to actively engage students with multimedia.

### Science Multimedia Analysis

<http://science.kqed.org/quest/files/downloads/2011/06/QUESTMediaAnalysis.pdf>

- Give your students the tools to recognize the purposes and messages of science multimedia.

### Create Online Science Hikes with Google Maps

[http://science.kqed.org/quest/files/downloads/2011/06/QUEST\\_ExplorationCreation.pdf](http://science.kqed.org/quest/files/downloads/2011/06/QUEST_ExplorationCreation.pdf)

- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

### Media-Making Toolkit for Science Education

<http://science.kqed.org/quest/education/media-making-toolkit/>

- Are you interested in integrating media making into your classroom or science education program? Find instructions, worksheets and rubrics for implementing simple media-making projects with students.

## OTHER WAYS TO PARTICIPATE IN QUEST

LOG ON

[www.kqed.org/quest](http://www.kqed.org/quest)

LISTEN

**KQED 88.5 FM San Francisco &  
89.3 FM Sacramento**

WATCH

**KQED Channel 9**

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## ALBINO REDWOODS: GHOSTS OF THE FOREST — QUEST RADIO TRANSCRIPT

## NOTES AND QUESTIONS

Park rangers in the Santa Cruz Mountains are protecting a decades-old secret. Actually, about eight of them. They are albino redwood trees. Pale and fragile, these so-called “ghost trees” are deliberately off the beaten track, as Amy Standen found out.

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KUTY: Did you see it? In advance?

Dave Kutty is a docent here at Henry Cowell Redwoods State Park.

STANDEN: Well, when you stopped, that was sort of a giveaway, but it is kind of weird looking.

We're looking at a stark white bush; it's about six feet tall and it's sprouted from the base of a normal redwood tree.

KUTY: It's not particularly tall. It's not particularly big. And so it could look dead.

Until you get up close. Albino redwood trees lack chlorophyll. Their needles are limp and waxy. The exact color of a glow-in-the-dark star you might find in a kid's bedroom. And while no one really knows for sure, they may be extremely rare.

KUTY: How rare? Some people say there's 25 in the world. Some people say there are 50.

And yet eight of them live here, three miles north of downtown Santa Cruz, with the rest scattered from Humboldt County to Big Sur. Henry Cowell Park has the largest known concentration of albino redwoods in the world. And that makes it the epicenter for a scientific mystery.

LYDON: You know, why here? Why this particular spot?

This is historian Sandy Lydon.

LYDON: Why this particular group of stump sprouts decided to come up albino?

Yes, there are albino humans, and albino alligators and albino coyotes. Albinism is a genetic mutation that pops up in many species. But albino plants are different.

LYDON: Most of the things that redwoods do have a purpose and that's, of course, to keep the organism alive.

Albino redwoods break that rule. Without chlorophyll, they can't convert sunlight into energy. The only reason they survive at all is because they are sprouts from an adult tree, connected at the root. So, for their entire lives, they suck energy from the mother tree.



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LYDON: They're parasites. They're freeloaders. They're not contributing a damn thing to the host tree. Nothing.

It's kind of like some 40-year-old who refuses to get a job, keeps eating his parents' food and sleeping in his old bedroom. Eventually, they'll cut him off. But in the case of the redwoods, this arrangement can last a hundred years or more. And no one knows why.

LYDON: They're mysterious. See, that's what makes them so cool.

Here's what we do know. Albino redwoods, even though they appear to be useless, are a symptom, you could say, of something that is very powerful in these trees. Something that State Park docent Dave Kutty says is key to the success of the entire coast redwood species.

KUTY: Redwoods are hexaploid. They have six genes per trait, as opposed to the two like we have.

Hexaploid means that coast redwoods have six sets of chromosomes—those DNA instructions that tell cells what to do. Genetically, that means they're playing with a much bigger deck of cards than we are. There are countless more combinations to play with, countless ways that a young tree can be just slightly different than its parents.

KUTY: They are thought to be the most adaptable tree on earth, by being able to change their genes so readily.

This is evolution in action. Every time a sprout comes up with slightly different genes, it's kind of like an experiment. If it works, that tree might set the course for the next generation of redwoods.

KUTY: They can develop resistance to fungi. They can develop resistance to viruses. They can develop better growth patterns.

And sometimes, they can develop a trait that is of absolutely no use to them at all—an evolutionary dead end.

KUTY: And as part of those experiments, we get albinos. And albinos probably aren't a particularly good modification, from the standpoint of the health of the forest, but they demonstrate there's a lot of experimentation going on.

Here's something else that albino redwoods illustrate: Time, or rather, time from the perspective of a redwood tree.

KUTY: This little branch fell off of this tree.

It's about as thick as a wine barrel.



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KUTY: Preliminary data says that's a 500-year-old branch.

This branch is as old as the Mona Lisa. But the tree it came from could be as many as 2,000 years old.

KUTY: So, on a time scale of things, this is a very old tree, compared to all the others. And yet to a redwood, it's just a disposable branch.

So, back to albino redwoods. To us, a hundred years may seem like a long time for a mother tree to keep feeding her useless, parasitic albino offspring. But to a redwood?

KUTY: It's just a little blink of the eye.

STANDEN: What do you see?

LYDON: What do I think?

STANDEN: What do you see?

LYDON: I see a white, redwood shrub.

If you didn't know what to look for, you'd almost certainly walk right by it. Lydon says that's the idea.

LYDON: And you'll notice here, at Henry Cowell, we've got a couple of them that are labeled, and then the rest of them we don't tell people about.

A few too many fans, taking home souvenirs, and these albino redwoods could disappear, entirely.

LYDON: You need to be an evolved human in order to be trusted with the information.

For QUEST, I'm Amy Standen, KQED News.