



Quests and Discussions for Students, Episode 6

Written by Ann Druyan
Produced by Cosmos Studios

Overview

In Episode 6, “Deeper, Deeper, Deeper, Still,” we learn how science casts its Cloak of Visibility over everything. It allows you to see yourself as a collection of a trillion, trillion atoms and to witness dramatic events that would otherwise be invisible to us.

Grade Levels

6-12

Episode Summary

We voyage to the bottom of a dewdrop to discover the exotic life forms and violent conflict that’s unfolding there. Our epic journey brings us to the nano-world of perhaps the best-



kept industrial secret of all time - photosynthesis. We barrel to the surface to encounter life's ingenious strategies for sending its ancient genetic message into the future.

We travel from a molecule of the scent of lilacs all the way to a memory, the processing of a single thought along the neural network of our brain...

The nature of the atomic structure of matter prevents us from ever really touching. Here it's made manifest in the context of a story of budding love between a young boy and girl.

The trees and plants around us, and the Earth itself, breathe in and out and we realize we never really noticed before.

An evening in ancient Greece comes alive to us as Democritus presents his magnificent conception of the reality of the unseen. We venture into his wine glass to experience the way carbon atoms affect us – and why they make for such a natural fit with life.

We enter the sanctum sanctorum of the cathedral of the nucleus and to the heart of the Sun to understand it as the fusion reactor it is.



We travel deep beneath the surface of the Earth to a place unlike any other, to discover nature's most mysterious known particle – the neutrino. And to the Temple of Ramses in Egypt where on two days of the year, the Sun's rays advance past the statues of the Pharaohs to enter the precincts of the gods. They always stop just short of the statue of Ptah, Lord of Creation. We travel to the equivalent place on the Cosmic Calendar, to come up against the wall that stands between us (for now, anyway) and the beginning of time.

The cell, the atom, the common dewdrop, are undiscovered realms awaiting our reconnaissance. To study, teach, and do science is to be part of an endless voyage of discovery.

Discussion Topics

- Put on science's Cloak of Visibility and using the mechanisms of science, describe your favorite pet. How many layers down can you see?
- In his *Lectures of Physics*, physicist Richard Feynman wrote, "If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis (or the atomic fact, or whatever you wish to call it) that all things are made of atoms..." If you were to decide what piece of scientific information could survive into the future, what would you choose it to be? Why would you choose that specific piece of information?
- How many members of the population of a dewdrop can you name?
- Is there a particular fragrance that triggers a memory for you? What is the molecular composition of that scent?

Proposed Activities

- Using the online resource, conduct a virtual experiment regarding photosynthesis. By moving the distance of a light source closer or further away from a sample of pond weed, students can measure the rate of photosynthesis in the plant.

Online Resources

- <http://www.reading.ac.uk/virtualexperiments/ves/preloader-photosynthesis-full.html>

Relevant Scenes from COSMOS

- Act One: Life in the Dewdrop
- Act Two: The Fragrance of Lilacs
- Act Three: A Radical New Idea
- Act Four: The Nucleus
- Act Five: Stalking the Wild Neutrino
- Act Six: The Nature of Light and Time

For a deeper dive, more subjects touched on in Episode 5:

- Atomic structure of matter
- Chemistry and biology of a dewdrop
- Competition between a paramecium and a dileptus
- Tenacity of the tardigrade

- Plant physiology
- Photosynthesis
- Evolution of plants and trees
- Strategies for reproduction
- Darwin's prediction of the Morgan's Sphinx moth
- Molecular composition of scent
- Neural network of receptors in humans
- Terrestrial respiration
- Birth of the scientific perspective in ancient Ionia
- Thales
- Democritus and atomic theory
- Mineral lattices
- Role of the carbon atom in building complex molecules
- Global warming
- The atomic nucleus
- Solar physics
- Supernovae
- Neutrinos
- Conservation of energy
- Egyptian solar mythology
- Photons
- Neutrinos from the Big Bang