

# ***“We Are Made of Stardust”***

## **8 to 12 session curriculum for primary school age groups**

by Connie Barlow • September 2007

Revised January 2010

<http://TheGreatStory.org/stardust-kids-lessons.pdf>

**The curriculum author, Connie Barlow, is a Unitarian Universalist. She has tested and used most of the elements of this curriculum as a guest teacher in children’s programs in nearly 50 different Unitarian Universalist congregations. She has done this while she and her husband, Michael Dowd, have lived on the road as “America’s Evolutionary Evangelists.”**

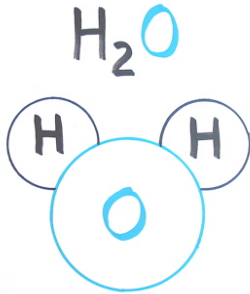
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# Guidance for Teachers

- **SUGGESTED VENUES:** This elementary curriculum is intended for **liberal religious education classes** and **private school settings** (in which values can be taught and there is no parental objection to children learning about evolution). It may also serve **homeschoolers**, especially multi-family gatherings.
- **AGE APPROPRIATENESS:** The dialogue suggestions are aimed largely for **upper elementary**. But because the story and the values teachings are also so important for **lower elementary**, I suggest that children be exposed to it in **combined age groups of 1<sup>st</sup> through 6<sup>th</sup> grade**. Ideally, each child would first be exposed to it in early primary school, in which case they would mostly be watching the older kids respond to the questions. Then, they would get a chance to revisit the curriculum in upper elementary—and now *they* would be the ones excitedly giving the answers. I have found that young kids can be very attentive while they watch the interaction of teacher and older kids. Of course, ideal class sizes are no larger than 12 to 20 students, so in the semester when this curriculum is being taught, the kids may need to be divided into **a number of cross-age groups**, such that **multiple teachers** are recruited to all teach the curriculum at the same time.
- **RELIGIOUS EDUCATION:** The author loves working in religious education/exploration programs for two reasons. First, kids tend to be **well rested on a Sunday morning**, whereas they may have a sleep-deficit during the school week. Second, there is **no testing in R.E. settings**. This means that both the teachers and the students can revel in *learning for the sheer joy of it*. Halleluia! I find that it is lots of fun to encourage the kids to **CALL OUT RESPONSES** spontaneously, rather than raise their hands. And it seems less like school!
- **EASE OF USE:** Each teacher may **adapt the lesson plans** to best fit their personal style and interests. Possibly, interact with the kids **extemporaneously**, using an outline or brief notes. But for those teachers who want more guidance, **a fully developed written “dialogue” is provided**. Teachers could read from this “script” and make extemporaneous adjustments and follow student-led tangents in real time, returning to the script when and where appropriate.
- **SEASON OF USE:** **Autumn**, timed to culminate the star theme just before or during the **Christmas** holidays. On **Thanksgiving**, we could also be grateful for stardust, and on **Samhain/Halloween** we would remember our ancestor stars.
- **MATERIALS:** Each lesson lists materials suggested, but you might also want to post around the room **Hubble Space Photos**, which can be acquired in large-format via <http://www.SkyImageLab.com>; you can then have them laminated at Kinkos. A great place to search for space photos is “Space Photo of the Day” site: <http://apod.nasa.gov/apod/astropix.html>. Print out the description and tape to the back of the photo, so that all teachers can consult what each photo is about.
- **FYI BACKGROUND:** <http://www.thegreatstory.org/Stardustbackground.pdf>



## 1. WHAT IS YOUR COSMIC AGE?

Stardust Curriculum by Connie Barlow  
September 2007

[www.TheGreatStory.org/stardust-kids.html](http://www.TheGreatStory.org/stardust-kids.html)

**Objective:** To help children feel *relationship*: that they are actually part of this vast and old Universe — not separate from it. Some will come to sense that they are, in a way, as old as the Universe itself.

**Materials:** a clear GLASS of drinking water; a hand-held DIAGRAM of a water molecule (above left) or a stick-and-ball model; WATER BALLOON; CHIME or bell. Some children prefer to learn while quietly drawing, so make sure that drawing materials (or puzzles) are available.

**Activity:** "Cosmic Age Ceremony" [by group together], with song: "As Old As the Universe": <http://thegreatstory.org/songs/old-as-the-universe.mp3>

**Lesson format:** Dialogue

**FYI:** The lesson asserts that our bodies are mostly made of hydrogen. This is true in terms of *numbers* of atoms. But hydrogen is the smallest of all atoms. So on the basis of *weight*, hydrogen atoms make up only 10% of our body's weight. 61% of our weight is oxygen atoms; 23% is carbon; 2.6% is nitrogen; 1.4% is calcium; 1.1% is phosphorus. Don't complicate the lesson by saying any of this; but, as the teacher, should be aware of it.

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**Begin by *sipping from your glass of water*, then ask:**

**Q: "If you had to name just one thing that our BODIES are made of more than anything else, what would it be?"**

[Wait for someone to guess "water".]

● **"Far more than HALF of each of our bodies is water—not just our saliva and sweat and blood and urine, but fluids throughout our bodies and inside each and every cell."** [Note: we're about 60 to 70%]

**Q: "WHERE exactly is all that water in our bodies?"**

[blood, saliva, fluids in eyeballs, stomach, intestines, urine AND also lots inside each and every cell]

**Q: "Why don't we just OOZE onto the floor if we are mostly water?"**

[Blood is inside veins and arteries; the outer membrane of a cell holds water like a BALLOON.]

● ***Pass around WATER BALLOON.***

**Q: "Does anybody have a story about a water balloon?"**

**Q: So we all need to drink liquids. "Who has a STORY about being really, really thirsty?"**

**Q: "What is the scientific name for water?"** [H<sub>2</sub>O]

● ***Hold up the DIAGRAM or model of a water molecule.***

**Q: "What does the "O" stand for?"** (Clue: "It is the same kind of atom that we breathe in.")

**Q: "Can we see the oxygen we breathe?"** [no]

**Q: "If water contains invisible oxygen, why can we see and feel and taste water?"** [because water is also made of another kind of atom: H]

**Q: "What does the H stand for in H<sub>2</sub>O?"**

● ***Hold up the DIAGRAM of a water molecule.***

[Answer: HYDROGEN. Note: It is unlikely that any child will know this.]

● **"When HYDROGEN is all by itself, it is just like OXYGEN: it is an invisible vapor, like an invisible cloud. But when HYDROGEN combines with OXYGEN into a molecule of water, and if enough molecules of water come together as a liquid,**

**then you can see it and touch it and taste it. It is water."**

- **"Now, let's just talk about HYDROGEN right now and leave OXYGEN to talk about another time."**

**Q: So, where do you think all those little ATOMS of HYDROGEN came from in the first place?"** [Let students guess for awhile. Usually, nobody guesses correctly.] Then explain:

- **"LET ME TELL YOU A STORY: In the beginning, when the UNIVERSE was born, there was a sudden flash of very very bright and very very hot light. It was like an EXPLOSION, but brighter and more powerful than any explosion you or I have ever seen—or even could imagine. Scientists tell us that this explosion was the beginning of the UNIVERSE."**

**Q: Does anybody know the name that scientists call this explosion?** ["The Big Bang"]

- **"Yes! 'THE BIG BANG'. Others like to call it 'THE GREAT RADIANCE' because this was the moment when everything would start expanding outward in all directions, like light radiating outward from the flame of a candle or a lightbulb or from a star. Both names, THE BIG BANG and THE GREAT RADIANCE, mean the same thing. They mean the time when the Universe was born."**

**Q: "Was PLANET EARTH already in existence when the Universe was born?"** [No.]

**Q: "How about our SUN?"** [No]

**Q: "Were there any HUMANS alive then?"** [No.] **Any DINOSAURS?** [No.] **"Why not?"** [Let them discuss.]

- **"There were no humans, no dinosaurs, not even stars in the beginning, because it all took time for them to develop—just like it takes time for a flower to grow from a seed. This is called EVOLUTION."**

- **"Okay. Back to our story: So when the UNIVERSE was born, all there was in the beginning was just ENERGY: the energy of HEAT and LIGHT. Then, when the energy of the**

**explosion started to cool, some of the energy cooled into PARTICLES even tinier than atoms. And then some of those tiny particles came together to form ATOMS."**

- **"Now here is how HYDROGEN comes into our story. HYDROGEN is the simplest of all atoms. It has the fewest parts in it, and so it is the smallest of all the atoms. So the Universe cooled mostly into a whole lot of HYDROGEN atoms and not much else. Not a single atom of OXYGEN was formed at that time, because oxygen is too complex. Not a single atom of CALCIUM formed back then. Not a single atom of GOLD formed then either. Almost nothing except HYDROGEN was born when the Universe began to cool."**

- **"Now here is the amazing thing: Every single atom of HYDROGEN in water and in your bodies—right now—came into existence when the ENERGY from the birth of the Universe cooled into atoms. So those atoms are very very OLD."**

**Q: "Exactly how old are they? Does anybody know how OLD the Universe is and, therefore, how old HYDROGEN atoms are?"** [14 billion years old; (actually 13.7, but round off to 14)]

**Q: "14 billion years old! Is a billion more than a million?"**  
[yes] **"Lots more!"**

**Q: "So if the Universe is 14 billion years old, and if all the HYDROGEN atoms in this glass of water are as old as the Universe, how old are they?"** [14 billion years old]

- **"Now, here is the amazing thing: Remember when we talked about how our bodies are mostly made of WATER? And water is mostly made of HYDROGEN because each atom of OXYGEN has 2 atoms of HYDROGEN stuck to it?" *Hold up the diagram of a water molecule.***

- **"So. If the atoms inside YOU are mostly WATER, and if WATER is mostly HYDROGEN, and if those HYDROGEN atoms are all 14 billion years old, then how old does that make you?"** [The children will mostly be silent, in a trance, so look at them intently in silence before continuing.]

- **"I'll give you an example. You may think I am kind of old**

**because I am XX years old. But that is just my HUMAN AGE. All the hydrogen atoms inside of me are as old as the Universe; they are 14 billion years old. In a way, I'm really that old too!"**

- **"Let's call the part of each of us that is 14 billion years old our 'COSMIC AGE'. COSMOS is another name for 'the Universe', and so COSMIC AGE is a good name for talking about the parts of our bodies that are really, really old. All the hydrogen atoms inside of us are just as old as the Universe is, because we are made of particles that were born when the Universe was very very young."**

- **"So a complete description of my own age is my COSMIC AGE plus my HUMAN AGE."**

- ***Pick up the chime or bell and say in a ceremonial voice:***

- **"My name is \_\_\_\_\_, and I am 14 billion and XX years old!"**

- ***Ring the chime.***

**Q: "Does anyone else want to say out loud what their own Cosmic Age plus Human age is?"** [Wait for a volunteer.]

- **"Good! So \_\_\_\_\_ is 14 billion and YY years old!" *Ring the chime.***

- **"Each and every one of you also has a combined COSMIC and HUMAN age."**

**Q: Does anyone else want to try saying theirs?"**

[Encourage several examples, and ***ring chime*** after each.]

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## **CONCLUDING CEREMONY: "Celebrating Your Cosmic Age"**

1. Decide on a spatial format: all sit on the carpet in a circle, or invite children to come forward and stand by you one at a time and make their announcement.

2. Introduce the ritual format, by saying that each of us will have a chance to say, "My name is \_\_\_\_\_, and I am 14 billion and X years old!"

3. Note: After each ritualistic announcement, you will hand the CHIME or bell to the child to ring.

NOTE: Find a way to encourage the children to get into a ceremonial mood. You might do this by lighting a CANDLE, or begin by asking the children what a ritual or ceremony is, and for examples of such. Emphasize how these are serious occasions, and silence is important to make it feel a little bit magical.

POSSIBLE **SONG** to teach at the conclusion of the ceremony (create your own gestures for it, or ask the kids to suggest a gesture for each subphrase). And then sing it over and over several times.

I am as old as the Universe  
You are as old as the Universe  
We are all one.

Click to LISTEN to an audio of the song at

<http://thegreatstory.org/songs/old-as-the-universe.mp3>





## 2. STARS IN "THE LION KING"

Stardust Curriculum by Connie Barlow  
September 2007

[www.TheGreatStory.org/stardust-kids.html](http://www.TheGreatStory.org/stardust-kids.html)

**Objectives:** (a) To help kids see that a mythic movie important to many of them can be enhanced by an understanding of science. (b) To begin to teach children that their very own ancestors include ancient stars! (c) To begin to talk about death of pets and relatives and other loved ones in a safe environment.

**Materials:** "Lion King" SCRIPT <http://thegreatstory.org/lion-king.pdf>. Possibly have hand-held PICTURES of the major characters in the movie: Mufasa, Simba, Pumbaa, Timon. Possibly purchase quarter-yard segments of colorful FABRIC to drape over the readers' shoulders, similar to the colors of the 4 characters in the scripts to be read. SOUNDTRACK of "The Lion King" and audio player.

### Activities:

1. Dramatic reading of "The Lion King" script segment by 4 volunteers.
2. Sing and dance to "Circle of Life" on the movie soundtrack.

### Lesson format: Dialogue

**FYI:** Many *older elementary school kids* will have watched The Lion King movie, and for some, it will be a mythic story (some will have watched it more than 20 times). This 1994 Disney movie celebrates the passage of life from infancy to childhood and then through careless adolescence and on to responsible adulthood. It shows the hero (Simba, a young lion) doing risky things, making mistakes, learning, and suffering the biggest loss of all: death of a parent. Finally, it shows Simba grown up and returning to his homeland to turn around the ecological destruction wrought under the rule of the previous generation (his wicked uncle).

## DIALOGUE SUGGESTIONS:

**Q: "Last time we met, we learned about our Cosmic Age. Who remembers how to say what their Cosmic Age plus Human Age is?"**

[Listen for as many examples as kids volunteer. Help the children who missed that program understand what Cosmic Age is, and how to say their Cosmic plus Human age.]

**Q: "How many of you have seen the Lion King movie?"**

**Q: "Has anybody seen it more than 10 times? 20? 50? 100?"** [ask why they like to watch it so much]

- "The stars in the night sky play a very important role in the movie. The first time the stars are important is right after the young lion, does something very bad, and he has to face his father about that.

*Possibly hold up the **PICTURES OF THE LION KING CHARACTERS**, one by one.*

**Q: What is the name of the young lion?** [Simba]

**Q: What is the name of Simba's father?"** [Mufasa, **Moo-FAH-sah**]

- "So Mufasa says to his son," [say in a deep voice]

**'Simba, I'm very disappointed in you!'**

**Simba then replies sadly, 'I know.'**

**And then Mufasa continues, 'You could have been killed! And you put Nala in danger!'**

**Simba replies, 'But I was just trying to be brave like you.'**

**Mufasa says, 'Simba, being brave doesn't mean you go looking for trouble.'**

- 'Simba, being brave doesn't mean you go looking for trouble.'

**Q: What do you think Mufasa means by that?** [listen to responses]

- "And then Mufasa tells Simba about why the stars in the night sky

**are important. Mufasa says:"** [say in a deep voice]

**'Simba. Let me tell you something my father told me. Look up at the stars. . . The great kings of the past look down on us from those stars. . . So. Whenever you feel alone, just look to the stars. The great kings will be there to guide you—and so will I.'**

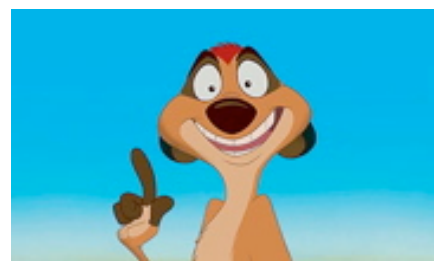
**Q: "Very soon in the movie, somebody dies. Who is that?"** [Mufasa, Simba's father]

**Q: "Why does Simba run away from home after he sees that his father has died?"** [Because he listens to his wicked Uncle, Scar, who wrongly tells Simba that it is Simba's fault that Mufasa died, and then Scar suggests to Simba that he should leave his homeland right now and never come back.]

**Q: "When Simba travels away from his homeland, he meets up with two animals who become his best friends. Who are they?"** [Pumbaa, POOM-bah, a warthog. And **Timon**, Tee-MOHN, a meerkat]



Simba



● **"When Simba becomes a teenager, his voice changes and he grows a mane. One night, Simba and his 2 friends are lying out under the sky and they talk about the stars. So here the stars become important for the story once again."**

**ACTIVITY: script-reading:** If there are at least 4 children old enough to read swiftly, and thus play-act from a script, a wonderful way to bring this component into stardust instruction is to have the **kids act out 2 scenes of the Lion King**, using the **"Lion King" SCRIPT** <http://thegreatstory.org/lion-king.pdf>. If there are more kids who can read, recruit kids to read the scripts through a second time. You take the role of "Narrator".

**DIALOGUE CONTINUES (after the script-reading is done)**

**Q: "So what did Mufasa teach Simba about what STARS are?"**

[great kings of the past]

**Q: "What did Timon believe stars are?"** [fireflies]

**Q: "What did Puumba think stars are?"**  
["balls of burning gas billions of miles away"]

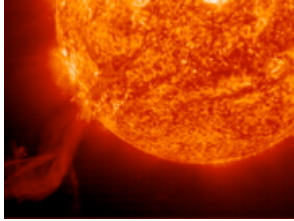
**Q: "Who is right?"** [Puumba says what scientists say: but the gas is hydrogen gas, not gasoline, so Puumba is right. But so is Mufasa. Stars aren't "great kings of the past" exactly, but they do include our ancestors. In fact, **STARS ARE OUR MOST ANCIENT ANCESTORS!**]

**Q: "What is an ANCESTOR?"**

*[Invite as many responses as kids have. Then ensure that all know that we all have ancestors: grandparents of grandparents who are dead. (You can easily help naturalize death by asking if anyone knows any particular ancestors in their family. Very interesting remarks, as in "an uncle who died before my mother was born.") In some settings the author of this curriculum has asked **children whether anyone has a grandparent who has already become an ancestor?** The kids seem very proud to be able to raise their hands! One boy spouted off the month and day (of that year) that his grandmother had become an ancestor. Be sensitive **that a child might have a parent who has already died**, and acknowledge great sadness about this, too. Overall, this dialogue that you make up can be a profoundly **empowering way to make it okay to speak about death**. Rather than a grandmother DYING, as in simply a loss, there is also an upside; **that grandparent became an ANCESTOR! Wow!** If you have a time, you can lead the children in understanding what a great- and a great-great grandparent is.]*

● **CONCLUSION: "Over the next several weeks we are all going to learn why it is that Mufasa and Puumba are both right. We will learn why it is that stars are "balls of gas burning billions of miles away" AND we will learn why stars are also our ancestors!"**

**SING-ALONG:** [play "Circle of Life" from the movie soundtrack, and encourage kids to sing and dance along] You might also have the soundtrack playing in the background as children arrive for their lesson.



### 3. "WHAT IS THE SUN CREATING?"

Stardust Curriculum by Connie Barlow  
September 2007

[TheGreatStory.org/stardust-kids.html](http://TheGreatStory.org/stardust-kids.html)

**Objectives:** (a) To learn how the Sun is creating heat and light. (b) To reflect on how dependent we are on the Sun.

**Materials:** A sheet of blank PAPER for each child (all must be the same size); colorful marking PENS. A LARGE BOWL. The CHART: "New Periodic Table of Elements". Click for a jpg photo of this chart:

<http://thegreatstory.org/charts/hi-res-photos-stardust.html>

Some children prefer to learn while quietly drawing, so make sure that drawing materials (or puzzles) are available.

**Activity:** Drawing dots on a half-sheet of paper to represent hydrogen atoms inside the sun and then crumpling that paper as tiny as possible.

**Format:** Dialogue

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#### DIALOGUE SUGGESTIONS:

**Q: "Who remembers what we talked about last time we met?"**

[Ensure that they recall that Timon thought stars were fireflies, Pumbaa thought stars were "balls of burning gas billions of miles away", and Mufasa told Simba that stars are ancestors. Possibly hold up the **PICTURES OF THE LION KING CHARACTERS, one by one.**]

**Q: "What is an ancestor?"** [wait for answers]

• "Last time I told you that during these next several weeks/lessons we would learn **WHY** it is that both Pumbaa and Mufasa are right: that stars really are 'balls of gas burning billions of miles away'—and that stars are our ancestors, too."

- **"So let us begin. Here is a question:**

**Q: What is the closest star to Planet Earth?"** [the Sun]

- **"Yes! Our SUN is a star. It is our very own star, and Earth is one of the Sun's family of planets. Right now, day in and day out, without any interruption, our Sun is using its immense GRAVITY to squeeze the simplest ATOM of all into a different kind of atom."**

**Q: "What is the simplest atom of all?"** [hydrogen]

- **"Yes! HYDROGEN!"**

**Q: "How old are all the hydrogen atoms found anywhere in the Universe?"** [14 billion years old]

- **"Yes! All the atoms of hydrogen everywhere in the Universe—including the hydrogen atoms inside all of us—are 14 billion years old. They came into existence right after the Universe was born."**

**Q: "Who remembers how old that makes each and every one of us?"**  
[14 billion years old.]

**Q: "Who remembers what we call that part of our age?"**  
[our "Cosmic Age"]

- **"Okay, so deep inside the core of our star, the Sun, it is using its immense GRAVITY to squeeze hydrogen atoms into the next simplest atom."**

**Q: "Can Earth do that, too, deep deep down inside? Can Earth squeeze simple atoms into more complex atoms?"** [no]

**Q: "Why not?"** [Earth is not big enough; the Sun is a whole lot bigger, so it has more gravity, and it can squeeze atoms together with a lot more heat and pressure.]

- **"If Earth actually *were* big enough to squeeze hydrogen atoms into another kind of atom, it would no longer be a planet."**

**Q: "What would Earth be instead?"** [a star!]

● **“That is the very definition of a star. A STAR is something in the Universe that is big enough to squeeze one kind of atom into another. And when a star does this, little bits of the atom are transformed into ENERGY: into heat and light.”** [FYI: as in Einstein’s famous equation:  $E=mc^2$ , where E is the symbol for Energy and m is the symbol for mass, and c is the speed of light]

**ACTIVITY: Pretending we are stars:**

1. [Distribute the half-sheets of paper and say we are going to pretend we are stars.] **“First, over the course of just 1 minute, see HOW MANY DOTS you can draw on the paper, using whatever color or colors you want. Each dot will represent a hydrogen atom. . . Ready . . . Go! . . . . . Stop!”** [Then have any child who wishes hold up their sheet to show all their dots.]
2. **“Now we are going to pretend we are stars, and inside we are SQUEEZING those hydrogen atoms as hard as we can. So get ready to crumple those sheets of paper into the tiniest balls that you can: . . . Ready . . . Go! . . . . . Stop!”**
3. **“Now let’s put them all together into a single BOWL and admire our work.”**

**DIALOGUE CONTINUES:**

**Q: “Who wants to volunteer to find the PAPER BALL in the bowl that somebody squeezed the hardest?”** [Pick someone.]

[As they walk toward the bowl, ask the whole class:]

**Q: “How could you tell which ball was squeezed the hardest?”**

[It will be the smallest]

[Wait for the child to choose a paper ball from the bowl.]

● **“Now hold up that little paper ball for all to see.**

**Q: “If the Sun had done the squeezing, do you think this ball would be even SMALLER? . . . Do you think it might be so small that we wouldn’t even be able to see it anymore?”** [let them discuss]

- **"Okay, so right now, the Sun is squeezing hydrogen atoms into the next simplest atom."**

**Q: "What is the NAME of that new kind of atom?"**

- **"Here is a clue: You are usually very near it when you go to a birthday party. . . . It has something to do with balloons."**  
[Wait for someone to guess "Helium".]

- **"Yes HELIUM!"**

**Q: "Does anybody know why helium BALLOONS will escape to the ceiling or into the sky if you let go of the string?"**

[Wait for someone to guess that helium is lighter than air.]

- **"Actually, helium is the second smallest element in the Universe. Only hydrogen is smaller and weighs less."**

**Q: "Has anybody here lost a helium balloon into the sky?"**

[listen to their story]

- **"Helium balloons rise up in the air because helium atoms are much smaller than the atoms that make up the air, including OXYGEN atoms. HELIUM is the second smallest element in the Universe. Only HYDROGEN is smaller and weighs less."**

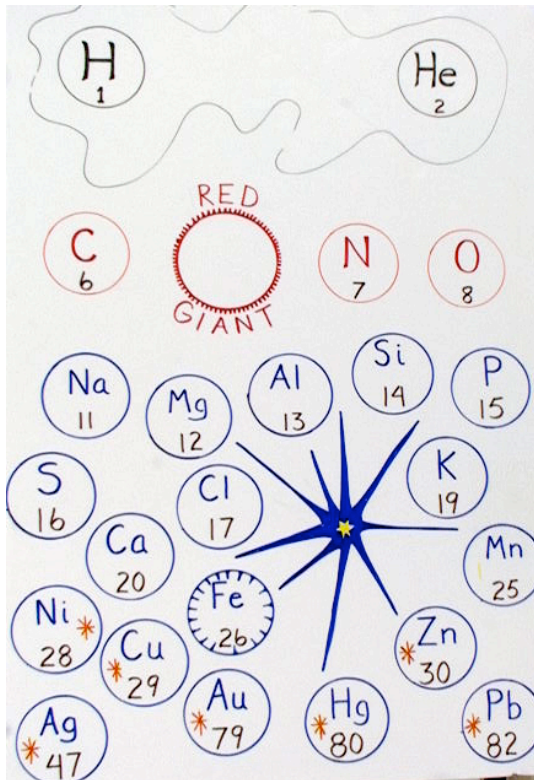
- **"Okay, so last century, scientists figured out that our Sun, right now, is making helium by squeezing hydrogen deep inside. And in the process of doing that, some of the particles inside of the hydrogen atoms that are getting squeezed are turned into ENERGY, and that energy escapes the Sun and some of it arrives on Earth as sunlight."**

**Q: "Do you think that SUNLIGHT is keeping you alive right now?"**

[Let them discuss. Warms the planet. The energy in all the food we eat is stored sunlight.]

***Set up the chart: "The New Periodic Table of Elements".***





**Q: "Where is HYDROGEN on this chart?"**

**Q: "Where is HELIUM?"**

- "The **LETTERS** are the nicknames that scientists have given to the different kinds of atoms. "H" stands for hydrogen. "He" stands for Helium."
- "The **NUMBERS** signify how many **PROTONS** are inside each atom. So the bigger the number, the more protons, and so the heavier it is. You can see that Hydrogen is the **SIMPLEST** atom of all, and Helium is the next simplest."
- "Next time we meet, we are going to talk about how and where all the **RED** color atoms on this chart are formed. Let's close with a song."

**Q: "Does anybody remember this song that we already learned?"**

Start to sing and gesture the song taught in Lesson 1, and encourage them to join in: "I am as old as the Universe. You are as old as the Universe. We are all one." FYI: Listen to an audio at:

<http://thegreatstory.org/songs/old-as-the-universe.mp3>



## 4. "Red Giants Made the Air!"

Stardust Curriculum by Connie Barlow

September 2007

[TheGreatStory.org/stardust-kids.html](http://TheGreatStory.org/stardust-kids.html)

**Objectives:** (a) To continue the explanation of why it is that our ancestors include ancient stars. (b) To convey that science doesn't diminish our sense of wonder but actually makes our awareness of the Universe even more exciting and wondrous than if it was just one big mystery. (c) To help children understand that the creativity going on inside the Sun and the other stars can be called by many different names: Cosmic creativity, the force of Nature, the powers of God or the Goddess or Allah, or Buddha nature.

**Materials:** CHART: "New Periodic Table of Elements", downloadable at: <http://thegreatstory.org/charts/hi-res-photos-stardust.html>

HUBBLE SPACE PHOTO of a white dwarf, such as the white sphere at the center of "The Eskimo Nebula" (3 pages below)

<http://antwpr.gsfc.nasa.gov/apod/ap031207.html>

Also, the "The Helix Nebula" ("Eye of God" photo, above):

<http://apod.nasa.gov/apod/ap090303.html>

PAINTING (see 4<sup>th</sup> page after this) that an artist drew of what a White Dwarf might look like on the inside. You can download this picture from the starryskies website (below). The Harvard website, listed after it, has more info on this discovery:

<http://starryskies.com/articles/2004/02/diamond.html>

<http://cfa-www.harvard.edu/press/archive/pr0407.html>

NOTE: Some children prefer to learn while quietly drawing, so make sure that drawing materials are available.

### Activities:

#### 1. Breathing with Red Giant Stars [group activity]

2. Singing "Twinkle Twinkle" and learning a new verse to it.

**Lesson format:** Dialogue

## **DIALOGUE SUGGESTIONS:**

**Q: "Who would like to SUMMARIZE what we talked about the last time we met?"** [Our sun is squeezing hydrogen into helium and giving off energy. That is what makes it a star.]

**Q: "Who would like to say what it was about the last time we met that was the most FUN for you?"**  
[Let all who raise a hand have a chance to speak.]

***Set up the chart: "The New Periodic Table of Elements".***

● **"Last time, we ended by looking at this chart: THE NEW PERIODIC TABLE OF ELEMENTS."**

**Q: "Who remembers what we learned about it last time?"**  
[Let kids discuss.]

● **"Today we are going to learn about the RED part of this chart."**

**Q: "What do you think the "C" stands for?"**  
Clue: something you breathe out: CARBON

**Q: "What do you think the "O" stands for?"**  
Clue: something you breathe in: OXYGEN

**Q: "What do you think the "N" stands for?"**  
Clue: It is the most abundant atom in Earth's atmosphere. NITROGEN

● **"Remember, the numbers signify how many particles (protons) are inside each atom, so the bigger the number, the more protons. And so the heavier that atom is."**

[For the short questions that follow, encourage the kids to call out the answers, WITHOUT raising hands.]

● **"So let me ask:"**

**Q: "How many protons are inside an atom of Oxygen?"** [8]

**Q: "How many protons are inside an atom of Carbon?"** [6]

**Q: "Is Oxygen heavier than Carbon?"** [yes]

**Q: "Is Helium lighter than Hydrogen?"** [no]

**Q: "What is written here?"** [point to 'Red Giant']

**Q: "Does anybody know what a RED GIANT is?"** [let them guess]

• **"A RED GIANT is an old star that has already used up all the hydrogen atoms in its core and turned them into HELIUM. So it starts squeezing helium into even heavier elements, and that makes it turn from the yellowish color of our Sun to a reddish color. So that is why it is called Red."**

Note to teacher: The carbon is created by helium fusion near the stellar core and then pushed out into the star's outer layers and even its atmosphere. Because carbon, oxygen, and nitrogen atoms prefer to combine into molecules (like CO, CN, and C<sub>2</sub>) in the atmospheres of carbon stars, and because these molecules all strongly absorb bands of bluer light, this gives these stars a deep red color. Periodically, "stellar winds" (star winds) blow the carbon-rich atmosphere out into space, which eventually results in the nebula of gases around a dying Red Giant Star. <http://apod.nasa.gov/apod/ap081218.html>

• **"It is called a 'GIANT' because it is now making a whole lot more heat and energy than it made when it was younger, and that means that it expands. It gets a whole lot bigger. So it becomes a Giant compared to what it used to be when it was just making Helium."**

**Q: "What are the 3 kinds of atoms that are made inside of RED GIANT STARS?"** [C (carbon), N (Nitrogen), and O (Oxygen)]

**ACTIVITY:** The chemistry of breathing

• **"Let's all take a deep breath . . . IN . . . and OUT . . . And again . .**

**Q: "What did we breathe in?"** [Oxygen]

**Q: "What else?"** [Clue: "It starts with an N." (Nitrogen)]

• **"Yes, NITROGEN. Earth's atmosphere is mostly nitrogen, and the next most abundant molecule in the air is oxygen. So we always breathe in a lot of nitrogen, but we just breathe it out again, because our bodies don't have any use for nitrogen in that form."**

**Q: "Now, what do we breathe out besides Nitrogen?"** [Carbon dioxide]

**Q: "Is CARBON DIOXIDE a kind of atom?"** [No. It is a molecule, because it is made up of more than one kind of atom.]

**Q: "What atoms make up a MOLECULE of carbon dioxide?"**  
[1 carbon atom with 2 oxygen atoms stuck onto it]

• **"One carbon atom that has 2 atoms of oxygen stuck onto it. That is why scientists call carbon dioxide, "C – O – 2" (Just like WATER is called H – 2 – Oh.)"**       $\text{CO}_2$     $\text{H}_2\text{O}$

**Q: "Does anybody know what a Red Giant star turns into when it DIES—that is, after it creates carbon and nitrogen and oxygen and then recycles those atoms back into the universe for the next generations of stars to use? What is left after a Red Giant dies?"**  
[White Dwarf; start to slowly sound out the name if nobody guesses it]

• **"A WHITE DWARF!"**



<http://antwarp.gsfc.nasa.gov/apod/ap031207.html>

**Show photo of "Eskimo Nebula" and point out the white dwarf in the center.**

• **"All the glowing stuff flowing outward and away from the white dwarf in the center of this photograph is what the Red Giant Star made during its final stage of life."**

• **"So flowing out of it are atoms of CARBON and OXYGEN and NITROGEN—as well as some of the HYDROGEN and HELIUM atoms that never got squeezed into any bigger atoms because they weren't deep enough inside the star."**

• **"So, when Red Giants finally finish their COSMIC TASK of making new atoms, they send some of those new atoms back into the Universe."**

- “Then the atoms that remain stop squeezing into new atoms and they just slowly COOL down. So now the same star is no longer called a Red Giant. It is called a WHITE DWARF. A White Dwarf is much smaller than a Red Giant, but most white dwarfs are bigger than the size of Planet Earth.”

- “Scientists say that the STAR HAS DIED when it becomes a white dwarf, because it is no longer making heat and light. It is just cooling down. It is no longer actually a star because it isn’t making heat and light anymore. It is just cooling down as a White Dwarf.”

**ACTIVITY:** Breathing with Red Giant Stars

- “So let’s all take a deep breath again . . . IN we breathe in oxygen and nitrogen . . . and OUT we breathe out nitrogen and carbon dioxide. . .”

**Q: “Now, who do we have to thank for those atoms of oxygen, nitrogen, and carbon dioxide that we just breathed in and out?”**

[Red Giants stars!]

- “Yes! Ancestor Red Giant stars who lived and died and RECYCLED their creations back to the cosmos before our own sun was born. It was Red Giant stars, who are now dead and shriveled into WHITE DWARFS, who created all those atoms.”

**ACTIVITY:** Singing “Twinkle Twinkle, Verse 1”

- “There is a song about stars that I bet just about all of you know. I will start singing it . . . Twinkle twinkle . . .” [keep singing and encourage them to join in]

**Q: “Did anybody learn the hand movements to this song?”**

[If so, encourage those kids to come forward and demonstrate as you all sing the song once or twice more.]

**MORE DIALOGUE:**

**Q: “In the song Twinkle Twinkle, what does the person who wrote that song say that stars are?”**

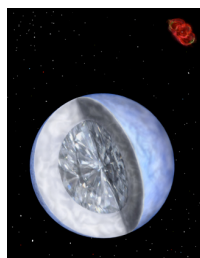
[Let them discuss.]

- “That SONG was written 200 years ago by a woman in England.

Back then, nobody on the planet knew what stars were, so everybody still kept **WONDERING** about them. People who speak English anywhere in the world have been teaching that same song to their children ever since. But now, thanks to scientists, we **DO** know what stars are. They are **BALLS OF BURNING GAS** billions of miles away—and they are our **ANCESTORS**.”

**Q: “Now here is a question to ponder: If scientists really have learned what it is that our Sun and other stars are doing, then do you think we should keep teaching and singing the SONG, ‘Twinkle Twinkle’?”** [Let them discuss, with no comment from you.]

**Show artist’s drawing of what the inside of a White Dwarf looks like.**



<http://starryskies.com/articles/2004/02/diamond.html>

- “This is not a photograph. It is a **PAINTING** by an artist who tried to draw what scientists think is inside some kinds of White Dwarfs. So the artist drew a White Dwarf with a chunk cut out of it, like cutting a chunk out of an apple to see the seeds inside. This way we could look at the inside of the White Dwarf.”

**Q: “What does it look like on the inside?”** [let kids discuss]

- “The smallest white dwarfs probably do look something like this on the inside. The smallest White Dwarfs are the dead bodies of rather small Red Giant Stars who had only enough gravity to squeeze Helium into **CARBON**. Bigger Red Giants that can also squeeze Helium into Nitrogen and Oxygen wouldn’t look like this, because the core of this dead star must be **PURE CARBON**.”

- “Here on Earth, pure carbon usually looks **BLACK**: It is the black stuff on burnt **TOAST**, or the black smoke made by a **CANDLE**.”

- “It is why **CHARCOAL** is black and a **LOG** turns black when it burns.”

- **"But if pure carbon is squeezed by a lot of gravity, the carbon atoms join together as a group and all turn into what you see in this picture. Here is a clue: Wedding rings sometimes have this crystal."**  
[diamond]

- **"Yes! A DIAMOND! Although diamonds are very rare on Earth, and they are created only very very deep inside the Earth from pure carbon, the Universe is full of diamonds."**

- **"In fact, the inside of a White Dwarf like this one probably contains one single GIANT crystal of a diamond that is bigger than our whole planet!"**

- **"So if there really are diamonds in the sky, we can still sing the original verse of TWINKLE TWINKLE and know that part of it is still true: ". . . like a diamond in the sky."**

- **"And we can also sing a SECOND VERSE to Twinkle Twinkle. This is a new verse written by a woman alive today. And this verse is a good way to remember what it is that stars are doing. I will sing it once and then we can all sing it together again:**

**ACTIVITY:** Twinkle Twinkle, verse 2

**Twinkle twinkle little star  
Now we know just what you are  
Making atoms in your core  
Helium and many more  
Twinkle twinkle little star  
Now we know just what you are**

[Sing it a second time with hand movements. Flash the fingers open straight and closed on each syllable of "Twinkle Twinkle". Point to your head on "Now we know". Point to the sky on "just what you are." Squeeze your hands together, on each downbeat, and then open on the next and flip to squeeze again for the next emphasized beat: "MAKING AToms IN your CORE". Fluff hands up and outward on "Helium and many more." Repeat twinkle, etc.]

**END: ●"Next time we meet, we'll talk about the blue atoms."**





## 5. "BIG BLUES MADE EVERYTHING ELSE"

Stardust Curriculum by Connie Barlow  
September 2007

[TheGreatStory.org/stardust-kids.html](http://TheGreatStory.org/stardust-kids.html)

**Objectives:** (a) To finish the explanation that our ancestors include ancient stars, and then to introduce the idea that we really are made of stardust! (b) To help kids realize how recent it is that scientists have been able to figure this out. (c) To convey that science doesn't diminish our sense of wonder but actually makes our awareness of the Universe even more exciting and wondrous than if it was just one big mystery.

**Materials:** CHART: "New Periodic Table of Elements", downloadable at: <http://thegreatstory.org/charts/hi-res-photos-stardust.html>

Hubble space photos of exploding supernovas, such as the M1 Hubble Crab Nebula (above left), or Cassiopeia A Supernova, or Tycho's Supernova Remnant: <http://apod.nasa.gov/apod/ap090317.html>

Extra photos:

1. Big Blue star (Wolf-Rayet) puffing out gases just before it goes supernova has a lovely photo at: <http://apod.nasa.gov/apod/ap090423.html>
2. Supernova remnant Cassiopeia A, with inset pointing to central neutron star that remains after explosion: <http://apod.nasa.gov/apod/ap110305.html>

NOTE: You can purchase large posters at SkyImage Lab: <http://www.SkyImageLab.com>.

Some children prefer to learn while quietly drawing, so make sure that drawing materials are available.

**Activity:** Singing the chant, "Burning, Churning, Turning"  
<http://www.thegreatstory.org/songs/stardust-burning-song.mp3>,  
with body movements

## Lesson Format: Dialogue

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### DIALOGUE SUGGESTIONS:

- "Last time we met we talked about this RED row of atoms in the NEW PERIODIC TABLE OF ELEMENTS." *Show the Chart.*

Q: "Who remembers what we learned about this chart last time?"  
[Let kids discuss.]

- "Today we are going to learn about the rest of the chart: all the atoms that are colored BLUE."

Q: "What do you think the "Al" stands for?"  
Clue: what soda pop cans are made of: ALUMINUM

Q: "What do you think the "Cl" stands for?"  
Clue: something you put in swimming pools: CHLORINE

Q: "What do you think the "Ca" stands for?"  
Clue: it makes your bones strong: CALCIUM

Q: "Do any of your families RECYCLE aluminum? . . . What kinds of things are made of aluminum?" [soda pop cans]

Q: "What COLOR of star makes atoms of aluminum before it dies?"  
[big blue stars].

- "Big blue stars, far bigger than our own star, the Sun, make all the rest of the atoms in the Universe."

*Show on the chart all the atoms that are blue.*

- "The atoms near the bottom of the chart are all the HEAVIEST atoms. The ones that have ORANGE asterisks by them are all made inside big blue stars right when they are DYING. They are made when the big blue star makes a huge explosion."

Q: "The type of explosion that Big Blue stars make is a word that begins with an S and has 4 syllables . . ." [Guess . . . "supernova"]

● **“Yes! A SUPERNOVA explosion! All the elements marked by an orange asterisk are created in the instant of a supernova explosion.”**

*Show photo of a Supernova, how the atoms are moving outward after the explosion. Then point to the supernova elements as follows:*

**Q: “The chemical symbol Au means something that WEDDING RINGS are sometimes made of . . .” [GOLD]**

**Q: “Ag is another kind of metal used for JEWELRY . . .” [SILVER]**  
[FYI: Zn is Zinc; Pb is Lead; Hg is Mercury; Cu is Copper]

● **“All of these kinds of atoms are made in the instant of a SUPERNOVA explosion—right when a Big Blue star dies.”**

**Q: “Does anybody remember from last time we talked the name of what a Red Giant star becomes when it dies?” [White dwarf]**

● **“White dwarf!”**

**Q: “Now, does anybody know what remains of a Big Blue star after it explodes as a SUPERNOVA?”** [either a “rotating neutron star” called a “Pulsar” or, if the star was big enough, there will be so much remaining that the intense gravity will pull everything into a BLACK HOLE.]

**Q: “Who knows what a BLACK HOLE is?”**

**Q: “Would any of you like to VISIT a black hole?”** [Some kids may say “No!” because if you get too close, it will suck you in and kill you.]

● **“Scientists discovered all this cool stuff during the last 50 years. And nobody knew any of this before then!”**

● **“Nobody knew what stars were. Nobody knew that stars were using their immense GRAVITY to squeeze one kind of atom into other kinds of atoms, and that this is what generated heat and light.”**

● **“And nobody knew that ANCESTOR stars who lived and died and recycled their creations back to the Universe had made the very atoms that are now in our bodies. . . . NOBODY KNEW THAT WE ARE MADE OF STARDUST!”**

**Q: Did any of you already know that? Did any of you already know that we are made of STARDUST — that all the atoms in our bodies, except for Hydrogen, were made inside of ancestor stars, who lived and DIED and RECYCLED what they had made back to the galaxy— long before our own star, the Sun, was born? . . . Did any of you already know that?**

[If any raise their hands, ask if they remember where they learned it.]

● **“So now that we know this — now that YOU know this — I have an important question. And this is a question for everybody, because everybody will have their own answer:”**

**Q: “Do you think that LEARNING about what scientists have discovered makes the Universe seem more WONDERFUL or less wonderful?”** [Let them discuss.]

**ACTIVITY:** “Burning, Churning, Turning” SONG.

**We are made of stardust burning  
churning and turning into animals**

*You can listen to the song online at*

*<http://thegreatstory.org/songs/stardust-burning-song.mp3>*

*Help the children remember the sequence because “B” comes before “C”, and “C” comes before “T”.*

*For body movements, sing very slowly, and explode your arms out on “stardust burning”, then make them roll in front of your chest for “churning”, then go down on all fours for “and turning into animals.”*

**ACTIVITY:** Conclusion: “CALL AND RESPONSE”:

**“So, what are you breathing?”** [stardust!] **“Louder!”** [stardust]

**“What are you wearing?”** [stardust]

**“What is your brain made of?”** [stardust]

**“What did you eat for breakfast?”** [stardust!]

**“What did you poop out yesterday?”** [stardust!]



## 6. "FINDING ANCESTORS IN THE SKY"

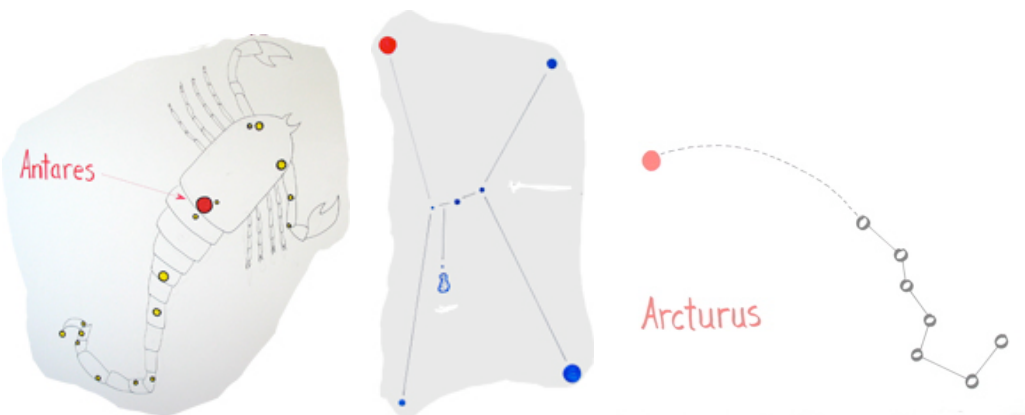
Stardust Curriculum by Connie Barlow  
September 2007

[TheGreatStory.org/stardust-kids.html](http://TheGreatStory.org/stardust-kids.html)

**Objectives:** (a) To help children learn to look for special red and blue stars in the night sky. (b) To help children understand that the creativity going on inside the Sun and the other stars can be called by many different names: Cosmic creativity, the force of Nature, the powers of God or the Goddess or Allah, Buddha nature.

**Materials:** CHART: "New Periodic Table of Elements", downloadable at: <http://thegreatstory.org/charts/hi-res-photos-stardust.html> (as used in the last several lessons).

Hand-held or poster sizes of 3 drawings (below) of easy-to-find constellations. Drawing materials so that kids who wish can draw the constellations to use as sky maps for finding the stars on their own.



Large reprint of comparison of the Sizes of Red Giant Stars:  
[http://www.saintjoe.edu/~dept14/environmentrogero/core5/celestial\\_compare.html](http://www.saintjoe.edu/~dept14/environmentrogero/core5/celestial_compare.html)

## Activities:

1. **Invite the children to look for the season-appropriate Red Giant stars this week from their home. Or do a sleep-over to look for stars, maybe watching "The Lion King" movie, too (as in Lesson 2) Or wait until you have finished Supplementary Lesson A, "Birthday Stars", so you can go out at night and look for those stars too.**
2. Children can draw copies of the constellations and mark where the Red Giants are so that they can use their drawings as sky maps to go out and look.

**Lesson format:** Dialogue

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## DIALOGUE SUGGESTIONS:

**Q: "What was the most interesting thing we learned last week?"**

[Encourage several responses.]

**Q: "Is this a true statement: 'We are made of stardust.'"** [discuss]

**Show the chart, "The New Periodic Table of Elements"**

**Q: "Is this a true statement: Our ancestors include stars."**

[let the kids discuss]

**Q: "Are the stars that we see in the night sky NOW really our ancestors?"** [let the kids discuss]

● **"The stars that are alive right now that we see in the night sky would not have been able to send any atoms toward Earth back when the Sun and Planet Earth were being formed."**

**Q: "When did the Sun and all the planets form?"**

[4.5 billion years ago]

● **"So, the stars we can see now are not our ACTUAL ancestors. But we CAN look at them and know that stars very much like them, but who all died a long time ago, are REALLY our ancestors."**

- “Those **ANCESTOR STARS** made all the atoms on Earth, including all the atoms right now in our bodies. There is just one kind of **ATOM** inside our bodies that ancestor stars did not make.”

**Q: What kind of atom is that?”** [Hydrogen]

- “Yes. Ancestor stars created all the atoms inside of us except for Hydrogen. Hydrogen was what the energy of the **BIG BANG** cooled into—even before the first stars were born.”

“So even though there are no **REAL** ancestors of ours in the night sky today, we can still go outside and look for Red Giants and Big Blues, and remember which kinds of atoms they are making.”

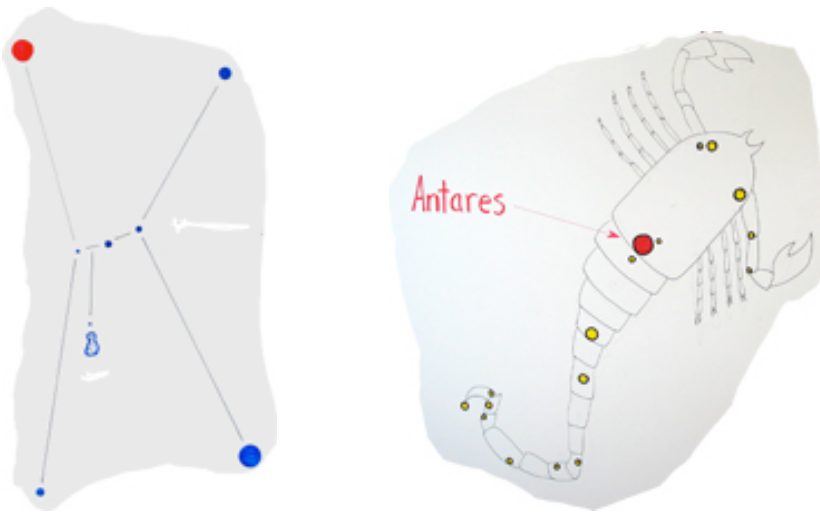
*Show the charts of the 3 constellations, one by one, and point out the important stars, conveying the information below extemporaneously:*

**1. Near The Big Dipper.** Best seen in the SPRING AND SUMMER. You find a beautiful Red Giant, **Arcturus**, by remembering “Arc to Arcturus”. First find the **Big Dipper**, then follow the arc of the handle to a bright orange star: Arcturus



**2. The Constellation Orion.** Best seen in WINTER AND SPRING. **Betelgeuse** is the Super Red Giant in the shoulder of the constellation Orion the Hunter. **Rigel** is the bright blue star in one of Orion’s feet.

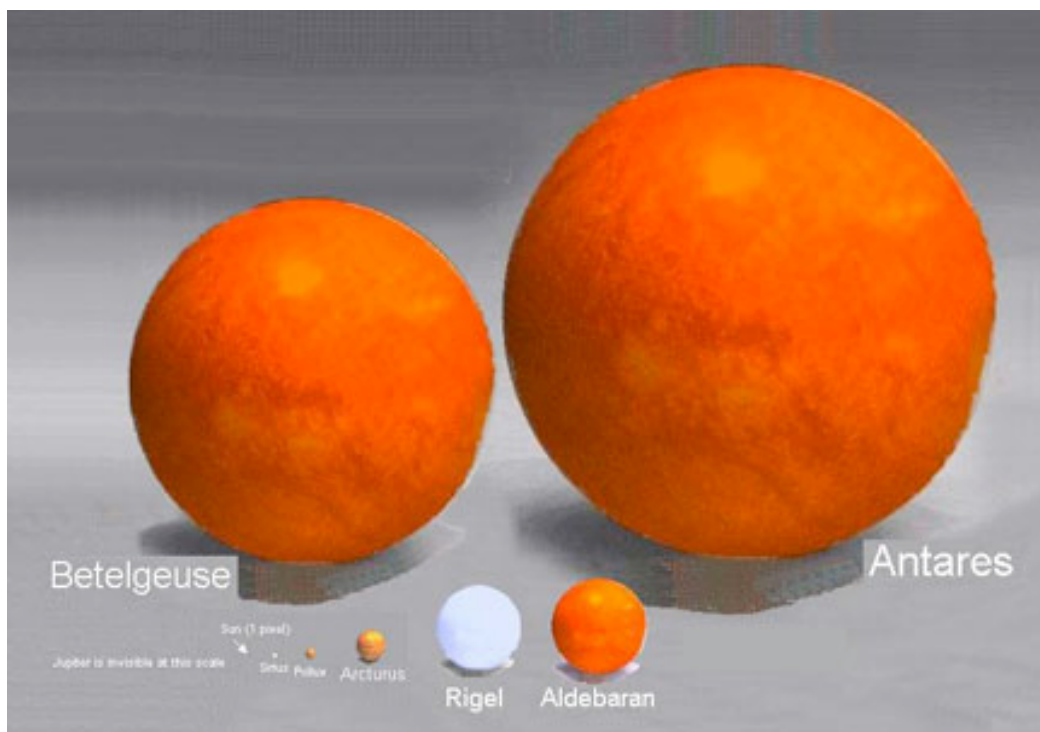




**3. The Constellation Scorpio (Scorpius, The Scorpion).** Best seen in SUMMER AND EARLY FALL, but only in the southernmost states, as it is low on the south horizon. Look for the reddish glow of super-red giant **Antares** right where the heart of the scorpion would be.

**4. The Constellation Taurus the Bull.** FALL AND WINTER. Look to the right and up from Orion the Hunter to see the constellation Taurus the Bull. **Aldebaran** is the bright orange star that marks the eye of the bull.

**Show the chart that compares the SIZES OF RED GIANT STARS**



**Q: "Let's take a look at this chart. What is the biggest Red Giant Star?"** [Antares] **"What constellation is ANTARES in?"** [Scorpius]

**Q: "What is the next biggest Red Giant?"** [Betelgeuse] **"What is its Constellation?"** [shoulder of Orion the Hunter]

**Q: "What about Aldebaran?"** [Al-DEB-are-on; eye of Taurus the Bull]

**Q: "How about the blue star, RIGEL?"** [knee or foot of Orion the Hunter]

**Q: "Next in size is ARCTURUS. How do you find Arcturus?"** ["Arc" to Arcturus from the handle of the Big Dipper]

- **"Now notice that our SUN, which is just an AVERAGE YELLOW STAR, is so small in comparison to these giants that you can barely see it on the chart."**

- **"Now I have a question that each of you will have your own personal answer for. There is no right or wrong answer. So just think about this question:**

**Q: When you learn the science about what stars are and what makes them bright and hot, and how atoms are made inside of stars, does this make you feel like the UNIVERSE is a more wonderful place to live in, or a less wonderful place? . . . Who would like to share their answer?"**

- **"Now here is one more important thing to think about. Scientists have discovered that stars are very, very CREATIVE. Stars in the past created all the atoms except hydrogen in our bodies. And stars alive right now are still creating atoms. PEOPLE have different ways to describe the creativity going on inside of stars."**

- **"Here are some NAMES that different people use to talk about all this creativity:"**

- **Some people call it COSMIC CREATIVITY**
- **Some people call it NATURE'S CREATIVITY**
- **Some people call it GOD'S CREATIVITY**
- **Some people call it THE CREATIVITY OF THE GODDESS**
- **Some people call it THE CREATIVITY OF ALLAH**
- **Some people call it Buddha Nature**

- “I wonder what name each of YOU might choose to talk about the creativity going on inside of stars. . . or what name you think your parents might choose.”

**Q: Which of all those names — or other names — do you prefer to use? Would you prefer to tell your friends and family that GOD is using gravity inside of stars to make new atoms? Or would you say that this is NATURE doing it? Or, would you say THE GODDESS? Or, what about a term that Buddhists use: BUDDHA NATURE? Or the Muslim name for God, ALLAH? Or do you like the name COSMIC CREATIVITY. Do any of you have preference?**

[Encourage responses.]

**Q: “Do you think there is any single right or wrong way to name the creativity going on inside of stars?”** [Let kids discuss.]

### **ACTIVITY:** Drawing SKY MAPS for the Red Giants

[Encourage the children to draw any or all of the constellations, to take home with them to use as Sky Maps for locating the Red Giants.]

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### **ACTIVITY FOR A LATER DAY:** Sleep Over

A **SLEEP OVER** for looking for ancestor stars in whatever constellations are visible in the evening of that season. If you do this, make sure you also do the activity from Lesson 4: “Breathing with the Ancestors”. Have everyone look at a Red Giant, breathe in Oxygen and Nitrogen, breathe out carbon dioxide. Then all say thank you to the star!

You can also sing the old and new verses of **Twinkle Twinkle SONG**, as in Lesson 4.

If you do a sleep-over, this would be a great time to do the final **Glitter Ritual** (Lesson 8), seated on the carpet or cushion in a circle, with a candle in the center. You could ask for volunteers to set up the ceremony.



## 7. "THE CIRCLE OF LIFE IN THE HEAVENS"

Stardust Curriculum by Connie Barlow  
September 2007

[www.TheGreatStory.org/stardust-kids.html](http://www.TheGreatStory.org/stardust-kids.html)

**Objectives:** (a) To sum up the main points of the previous five Stardust lessons. (b) To talk about DEATH in the context of the death of stars. (c) To have children grasp that "The Circle of Life" (the song in the Lion King movie) is important for everything in the Universe. (d) To have the kids "imprint" on the Hubble photograph "Pillars of Creation" and to feel special about being a child alive in the Universe today.

**Materials:** Have spread around the room for easy viewing and retrieval all of the CHARTS and PHOTOS used in all the previous lessons. Add to this collection a new photo: the Hubble space photo called "The Pillars of Creation" (above left). Also have a poster of the famous "Earth from Space" 1968 photo. NOTE: You can purchase large posters of both of these images through SkyImage Lab: <http://www.SkyImageLab.com>

Optional: Supplement the "Earth from Space" photo with this moving video on YouTube about the 1968 image of Earth "rising" over the moon ("Earthrise"). The astronauts voices are included in the video:  
<http://www.youtube.com/watch?v=TmaOcPYCGMA>

**Supplemental activity:** Watch BBC Video "The Death of the Sun"  
[Preview it on YouTube:  
<http://www.youtube.com/watch?v=NU59BMdQ7z4> ]

**Or possible closing RITUAL: "Cosmic Communion" [see next lesson]**

**Lesson format:** dialogue

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### DISCUSSION SUGGESTIONS:

**Q: "WHO wants to say what they remember most from our time together last week?"** [Let any who wish say something.]

**Q: "WHO remembers what their COSMIC AGE is?"** [14 billion years]

**Q: "WHO remembers the name of the ONLY ATOM that is not made inside of stars?"** [Hydrogen]

**Q: "Who remembers the name of the atom that OUR SUN is right now squeezing Hydrogen into?"** [Helium]

**Q: "Who remembers what kind of stars make the OXYGEN we breathe?"** [Red Giant stars]

**Q: "Who remembers the name of any atom that Big Blues create?"**  
[refer to the New Periodic Table of Elements chart]

**Q: "Who remembers the name of any atom that is created during a Supernova explosion?"**

**Q: "Who has ever seen a Red Giant star up in the night sky with their own eyes, and which one did you see?"**

**Q: "Who wants to share what name they like to use to talk about the creativity going on inside of stars."** [Hint: examples include Cosmic creativity, God's creativity, Nature . . .]

**Q: "Has anybody here told somebody else — at school, in your family, maybe a friend — that we are all made of stardust? . . . What was their response?"**

**Q: "Who thinks it is a sad thing that stars have to die?" . . . "Why?"**

**Q: "Who thinks it is a good thing that stars die?" . . . "Why?"**

● **"Let's talk more about why it might be a good thing that stars die. Here's what we can think about:"**

● **"When the Universe was born 14 billion years ago, during the Big Bang or The Great Radiance, the energy cooled into WHAT KIND OF ATOMS?"** [hydrogen]

● **"And then gravity had some of those hydrogen atoms come back together to form stars. When enough atoms came together, the pressure at the core grew strong enough to begin squeezing**

hydrogen atoms into **another kind of atom . . .**" [helium]

- "So this is what was going on when the first stars were born."

**Q: "Now here is the question: Do you think there were any PLANETS orbiting those first stars?"** [No rocky planets, because you need lots of kinds of atoms to make planets.]

- "So those first stars had to turn into **RED GIANTS** and **SUPERNOVAS** and then pulse or explode the atoms they created back into the Universe. When enough of them **RECYCLED** their atoms after they died, then new stars being born would have enough material around them to make **PLANETS**—and maybe some of those planets could make **LIFE**, like our Earth has made life."

- "So here is the thing: "Without the death of stars, there could be no planets and no life . . . Does that make sense to you? . . . *Without the death of stars, there could be no planets anywhere in the Universe, and no life.*"

**Q: "Is our Sun a star?"** [yes. It is an "Average Yellow Star" ]

**Q: "Does this mean that our Sun is eventually going to turn into a Red Giant and die?"** [yes]

**Q: "Is this something we need to worry about?"** [Let them discuss. Make sure you tell them that our Sun won't turn into a Red Giant until another **5 billion years have gone by**, and that is a very very long time.]

**Q: "Did you know that YOU, sitting right here, are THE FIRST GENERATION to have a chance to learn and think about what it means that stars die—and that it is IMPORTANT for stars to die, in order to make planets and life possible in this Universe? . . . Isn't that amazing?"**

- "Your grandparents didn't have a chance to think about this as kids, and most of your parents didn't either."

- "In the past, because stars live for so long, and because the **CONSTELLATIONS** of Orion and Scorpio and the Big Dipper look exactly the same as they looked a couple thousand years ago when people gave them names, people thought that the stars were **IMMORTAL.**"

**Q: "What does 'Immortal' mean?"** [live forever; never die]

- “Okay, so all of our great-great-great grandparents thought that stars were immortal — that stars lived forever. But this was very different from what they saw right here on Earth. Here on Earth they saw that **PEOPLE DIE**, and **ANIMALS DIE**, and **TREES DIE**. Yet, when they looked up into the night sky, they thought they saw that nothing died. So some of them concluded that there must be **SOMETHING WRONG** with our own planet. They thought that there must be something wrong that animals and plants and people have to die.”

- “They thought there was something wrong with Planet Earth — because nothing that lives here is **IMMORTAL**. Everything dies eventually. Some of our ancestors thought it would be much better if people lived forever, because it is very, very sad when somebody we love dies.”

**Q: “WHAT DO YOU THINK? Do you think there is something wrong with our planet because trees and animals and people have to die eventually?”** [Let them discuss.]

**Q: “Do you remember THE LION KING talking about “the circle of life”?”** [See if anyone can tell about the scene where Mufasa explains to Simba that Lions die and become grass, and then the other animals eat the grass, and then later generations of lions eat the zebras and the antelope.]

**Show the famous photo of “Earth from Space”.**

**Q: “How many of you have seen this photograph of the whole Earth as seen from a spaceship?”**

- “This is the **MOST FAMOUS** photograph of the last century. It was taken in 1968 and it made a huge impression on the people who were alive at that time — including your grandparents and maybe even your parents. It shaped their whole way of seeing the world.”

**If you have a way to show a You-Tube video, consider showing this moving video of the taking of the famous “Earthrise” photo from the moon in 1968: <http://www.youtube.com/watch?v=TmaOcPYCGMA>**

**Show the “Pillars of Creation” Hubble Space photograph.**

- “Now here is the photograph for **YOUR GENERATION!**”

- “It is called **THE PILLARS OF CREATION** and it shows part of the Eagle Nebula that is inside our own galaxy, the Milky Way.”

**Q: "What does the word "PILLARS" mean?** [standing tall, towers]

- "This Pillars of Creation photograph was taken by the most famous TELESCOPE that was launched into space and orbited Earth, and was able to take sharp pictures of the Universe up its equipment began to fail around 2008."

**Q: What is the name of this most famous telescope?"** [Hint: It rhymes with Bubble.]

- "To give you an idea of scale, these pillars are so tall that if our Sun was put into the picture, we wouldn't even be able to see it. Our whole solar system would be tinier than the tiniest pink dot we can see." *Point to a tiny pink dot.*

**Q: "The pillars look like billowy clouds. What do you think they are made of?"**

- "The pillars are mostly made of 14 billion-year-old HYDROGEN atoms that have clumped together. The pillars also contain YOUNGER ATOMS that were created inside of ANCESTOR STARS, and that were then exploded out when those stars died."

**Q: "Why do you think this photo is called 'The Pillars of Creation?'"**  
[Give hints to help them think of the idea that stars are being born right now in those columns and those stars will create even more atoms.]

- "This part of our Milky Way Galaxy is one of the most active star-forming regions in the whole galaxy."

*Point to the GLOWING top of the LEFT column and say:*

- "Right now, BABY STARS are being born right here. . . . Isn't that amazing?!"

**Q: "Do you think that any of those STARS being born right now might eventually have PLANETS around them?"**

**Q: ". . . And do you think that some of those planets might eventually give birth to life?"**

**Q: ". . . Do you think alien life forms will look anything like the life we have right here on Planet Earth?"**

**Q: ". . . How many of you think that 'THE PILLARS OF CREATION' is**



a beautiful picture?"

Q: "... How many of you think that this UNIVERSE is a beautiful place to live?"

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**ACTIVITY:** The above discussions are really important and can be allowed to continue for a long time. So you might not want to have any other activity. Or, if there is time, you could watch the half-hour BBC movie about death of the Sun. Or, play "The Circle of Life" song from The Lion King.



## 8. "COSMIC COMMUNION CEREMONY"

Stardust Curriculum by Connie Barlow  
September 2007

[www.TheGreatStory.org/stardust-kids.html](http://www.TheGreatStory.org/stardust-kids.html)

**Objective:** To provide a memorable CEREMONY as the culmination to all the weeks of learning "We are made of stardust!" (all the previous 7 lessons)

**Materials:** POSTER (above left) to help children sing the stardust chant during the ceremony. Download the poster at <http://thegreatstory.org/charts/hi-res-photos-stardust.html>, or draw your own. Fairy dust GLITTER (fine enough to stick on dry skin)—not the coarse glitter. A small BOWL or CLAMSHELL to hold the glitter and be passed from hand to hand. A CANDLE for the center of the circle. A room that can be made fairly dark. Carpet or cushions for sitting on the floor. Have the room brimming with all the charts and posters they saw in their previous lessons.

**Activity:** Stardust ceremony: "Cosmic Communion", in which children receive and give glitter as a symbol of stardust, while singing the Stardust chant. Click here to listen to the Stardust chant:  
<http://thegreatstory.org/songs/stardust-song.mp3>

**Lesson format:** Ceremonial

**Youth participation:** It may be helpful to invite the YOUTH (or selected ambassadors from the teen group) to join the ceremony and sit amidst the younger kids in the closing circle. Here is why: Some elementary age kids may be physically uncontrolled, so it would be important to assign 2 teens to sit on either side of that child. Also, some children are very timid, so a teen could be recruited to sit on the side that would have the teen glittering the timid child. A third reason is that it would give teens a chance to revisit a ritual that they themselves experienced at an earlier age. They could enjoy it because they knew they had responsible jobs to play, and so there would be no worry of doing something childish. They could enjoy it too, but in a more adult-like capacity. Maybe even invite the youth to take responsibility for designing the room, and obtaining all the accoutrements (candle, chime, shell) necessary for the event. Maybe even request the youth to lead it.

**Rite of Passage Possibilities:** One possibility would be to turn this into a special event, such as a sleep-over, especially in conjunction with star-gazing, as recommended in Lesson 6: Finding Ancestors in the Sky. For a sleep-over, there would be time to call each child individually into a special ceremonial room in which several beloved teachers (and the minister) would be present. The teachers (wearing costumes?) would speak ritualistically, maybe beginning with “You are made of stardust. You are a special child of the Universe. In your future there will be . . .” and say something really positive, but nonspecific, so that the child has a memorable sense of something big having just happened to them and feeling excited about the future. Teachers who know the special gifts of the child would want to mention those during this time and provide encouragement. Then, after each child has had their own secret time with the teachers, the closing ceremony would begin. A **physical token** would, of course, need to be given to the child during this time. Some token of achievement, preferably the same for each child. Or, maybe a **colorful glittery scarf** would be draped over their shoulders when the teachers began or ended their secret talk to the child. And then the child would wear this during the ceremony. Perhaps the **YOUTH** could have worked the previous weeks shopping for the fabric and designing special insignia.

## **SUGGESTIONS FOR CEREMONY**

***NOTE: You must speak extemporaneously for this whole lesson, so make yourself some key word notes for guidance.***

- **WHAT IS A RITUAL OR CEREMONY?** Help the kids to become quiet and to feel ritualistic. Ask them what a ritual is, and what a ceremony is. Ask for examples. Encourage them to be serious and quiet once the ritual begins.

- **WHAT IS THIS?** Before the ritual begins, carry the vessel with Fairy Dust Glitter around for each of the children to see. What is this? [Once it is established that it is glitter, ask them what glitter is. Wait for someone to say, “Stardust!”]

*SAMPLE INSTRUCTIONS: “Stardust! Everything is, of course, stardust. But glitter looks more like stardust than anything else! To show that we are made of stardust, each of us in turn will gently, quietly, put a dab of stardust on our neighbor. When it is your turn to receive stardust, point to whether you want it to be put on your forehead or on the back of your hand. I’ll*

*demonstrate. Here's the bowl: Now I am going to indicate to my neighbor that I'd like her to put the stardust on my forehead. Then it is my turn to take the bowl and do the same to my neighbor."*

- **TEACH THE CHANT.** Before you start the ceremony, teach the kids the song below, so that when you light the candle and come into circle you all can keep singing it over and over, while the glittering is happening. Let them know that when it is their turn to glitter or receive the glitter, they will probably want to stop singing so they can concentrate on the glittering. And that is okay. [I sometimes find that the kids are so mesmerized by watching others get glittered that only I and the other adults in the room are singing the song over and over, and that is perfectly okay!] I use a chant-tune, with these words, and this picture to sing-along with:

We are made of stardust, every single atom,  
of carbon and of oxygen, calcium and iron.



*Note: carbon is signified by burnt toast, oxygen by a cloud, calcium by bone, iron by blood.*

- Click here to listen to the Stardust chant:  
<http://thegreatstory.org/songs/stardust-song.mp3>
- Click here to download the poster:  
<http://thegreatstory.org/charts/hi-res-photos-stardust.html>

**CLOSING THE GLITTER RITUAL.** Kids really quiet down and become very serious when sitting in a dark room with a candle and doing the glittering while the song is chanted. Even mildly autistic kids do just fine in such a setting. After the singing ends, you might introduce a CHIME or bell, and say that the final part of the ceremony is for each of us in turn to SAY THE NAME OF SOMETHING WE LOVE THAT IS MADE OF STARDUST [my cat, my mom, etc.], and then ring the chime softly and pass it to the child next in the circle.

For this one, I have us all go quiet for a moment to think about what we want to say, then I start by saying the one word (like, "redbud trees!"), then I ring the chime, and then pass the chime to the child next to me, so that the chime is passed in circle, rather than to raised hands.

**Finally, lay out a plan for everyone to crawl toward the central candle, and on the count of three to blow it out.**

**THE END.**



## Supplementary Lesson A: "Birthday Stars"

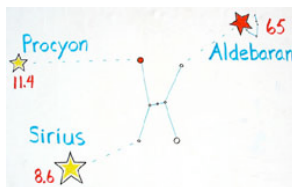
Stardust Curriculum by Connie Barlow  
September 2007

[TheGreatStory.org/stardust-kids.html](http://TheGreatStory.org/stardust-kids.html)

<http://thegreatstory.org/birthday-stars.html>

BACKGROUND: Because stars are so distant, the photons reaching our eyes today began their journeys in the past. Thus **we see stars as they were, not as they are**. Our own eyes serve as time machines, taking us back into the past.

Star distances are measured in **light-years**: the distance over which light travels in one year (a little less than 700 trillion miles). The numbers in the chart below are light-year distances for stars close enough to our own solar system to serve as "birthday stars" or "anniversary stars" in the human lifespan. For example, **Arcturus** (at 36.7 light years away) is the birthday star for those 36 or 37 years old. It is easy to find because it is so bright, it is a distinctive reddish hue (being in its "Red Giant" phase of life), and one can easily find it by "arcing to Arcturus" along the curvature established by the handle of the BIG DIPPER (this part recapitulates Lesson 6).

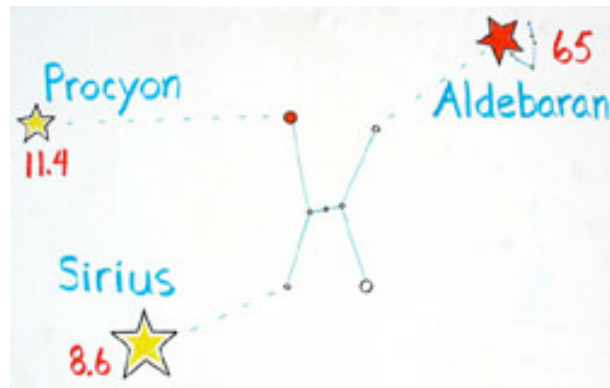


### Sirius: The Star for 8-year olds

The YOUNGEST BIRTHDAY for which a birthday star can be easily seen in the night sky is children turning 8 years old. **Sirius**, the brightest star in the winter sky, is the birthday star for 8 year olds.. A wonderful **rite-of-passage** sleep-over could be scheduled at the church for 8 year olds, but only in the LATE WINTER or SPRING, when Sirius is visible well above the horizon early in the evening.

Click for website access to the full BIRTHDAY STARS program and charts:

<http://thegreatstory.org/birthday-stars.html>





## Supplementary Lesson B:

### "Startull: The Story of an AverageYellow Star"

Stardust Curriculum by Connie Barlow  
September 2007

[TheGreatStory.org/stardust-kids.html](http://TheGreatStory.org/stardust-kids.html)

<http://thegreatstory.org/stardust-parable.pdf>

***When to use:*** Because this parable assumes children have been taught that ancestral RED GIANT and BIG BLUE stars created all the atoms crucial for life, this PARABLE could be used **any time after Lesson 5.**

Note: A dramatic way to remember the science used in this parable is to have a teen or adult singer learn and perform the **"In the Beginning"** chant written by Connie Barlow, and to do this right before the parable is acted out:

<http://thegreatstory.org/songs/in-the-beginning.html>

***Values taught by the parable:*** accepting self and others; balancing humility and pride; trust in the ways of the universe; death as natural and important even among stars; giving back to the universe from one's personal talents; mentoring; naturalness of growing up; stages in life; patience; being average is OK!; creating is cool!; embracing the circle of life; acceptance of imperfections; we all have something to offer; appreciation of diversity; change happens; interdependence

***Involving youth:*** Even though the scripts can be acted out by good readers in upper elementary grades *with no advance preparation*, the best use in a church setting would be one of two venues:

1. Have older kids or adults rehearse their parts for eventual performance at an INTERGENERATIONAL SERVICE, to begin or end the 8-part Stardust



Lessons. Because the parable includes a character who becomes an elder and a mentor and then goes off to die after being “very satisfied with the star life I have lived”, it is also a powerful experience for adults.

2. Recruit YOUTH to rehearse the play and then invite them to present it in the classroom to the younger kids—sometime after Lesson Number 5, so that the young kids are already familiar with the science.

Ideally, children in church settings would first be exposed to “Startull” in the elementary grades, perhaps more than once. They could then look forward to entering middle school, when they would get a chance to perform or create costumes or stage sets for “Startull” to present to younger kids. This way, the same story becomes a beloved part of their LIFE HISTORY and marks age-relevant RITES OF PASSAGE.

For SECULAR, JEWISH, PAGAN, and HUMANIST associations or congregations, The Startull Parable could also be scheduled for performance during the CHRISTMAS season, so that it could provide all age groups with a powerful and meaningful substitute for the stories of Jesus’ birth that provide such a memorable and heart-rich focus for Christian children and adults. And yet it also contains a beloved seasonal symbol: a STAR. In this case, the “We Are Made of Stardust” curriculum would be excellent for the post-introductory fall Religious Education/Exploration program. Halloween/Samhain could be interjected as a break in the curriculum, or directly connected to the remembrance and honoring of ancestors, including ancestral stars. Thanksgiving could be connected to the sense of gratitude for the gifts of Ancestor stars.

Click here for a PDF of the **4-part script**:

<http://thegreatstory.org/stardust-parable.pdf>



## Supplementary Lesson C:

# "This is Your Universe"

Stardust Curriculum by Connie Barlow  
September 2007, revised December 2009

**TheGreatStory.org/stardust-kids.html**

**Objective:** To give kids a general sense of the whole Universe, and to ensure that they feel a warm relationship to the Universe, that they have a sense that they are important, even though the Universe is vast.

**Suggested use:** This lesson could be scheduled either before Lesson 1 or after the whole Stardust lesson sequence has concluded.

**Materials:** A COIN the size of a quarter. Two DINNER PLATES. Enough DRINKING STRAWS for each child to have one. A CHART for reference with this on it:

1 HUNDRED	100
1 THOUSAND	1,000
1 MILLION	1,000,000
1 BILLION	1,000,000,000
1 TRILLION	1,000,000,000,000

Decorate the room with beautiful Hubble Space PHOTOS, but have these 3 particular photos available for use at the front of the room:

1. Andromeda Galaxy (photo above left)
2. Hubble Deep Field  
<http://antwrp.gsfc.nasa.gov/apod/ap000709.html>
3. Hubble Ultra Deep Field  
<http://antwrp.gsfc.nasa.gov/apod/ap040309.html>

All photos can be ordered online in a variety of sizes:  
<http://www.SkyImageLab.com>

The chart of Arcturus and The Big Dipper:  
<http://thegreatstory.org/charts/hi-res-photos-stardust.html>

An audio of **"The Galaxy Song"**, by Monty Python. You can listen to this song for free, and see the text of the lyrics, at:

[http://www.gecdsb.on.ca/d&g/astro/music/Galaxy\\_Song.html](http://www.gecdsb.on.ca/d&g/astro/music/Galaxy_Song.html)

**Activity:** "The Galaxy Song", Monty Python.

**Follow-up Activity:** Ask the children to all bring in BABY PICTURES of themselves. Then, at your next time together, use tape to stick those onto the "baby picture of the Universe" (Hubble Ultra Deep Field).

**Lesson format:** discussion

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## SUGGESTED DIALOGUE

### PART 1: THE MILKY WAY

**Q: "What is the name of our galaxy?"** [Milky Way]

**Q: "Have any telescopes taken a photograph of the Milky Way?"** no

**Q: "Why not?"** [We are inside the Milky Way, and we can't get outside of it to take a picture.]

**Show Andromeda Galaxy photo.**

- "If we were able to send a SPACESHIP out beyond our solar system and then way out beyond our galaxy, scientists think that our Milky Way would look similar to this, because this is a SPIRAL GALAXY, and the Milky Way is a spiral galaxy too."

- "This is a real photograph of the galaxy that is the nearest neighbor to our own Milky Way. This is the closest galaxy to ours, and it happens to look a lot like our Milky Way looks."

**Q: "Does anybody know the name of this galaxy?"** [Clue: Start to sound it out . . . An-dro- . . . . Andromeda!]

- "Andromeda! . . . . Now let's PRETEND for a moment that Andromeda Galaxy is our own Milky Way Galaxy, and that we are

looking at it from the outside. Can we all imagine that? . . . Let's imagine that this is a photograph of our own Milky Way Galaxy . . ."

**Q: "If this were the Milky Way, where do you think our Solar System would be inside of it?"** [Let them guess for awhile.]

**Q: "Here is a clue: Does anybody know what is at the very center of most spiral galaxies, including our Milky Way?"** [a black hole]

- **"A BLACK HOLE!"**

**Q: "Do you think it would be a wise idea for our Sun and planets to be very close to a black hole? . . . Why not?"** [you could get sucked in]

- **"Another problem is that stars are much CLOSER together the closer you get to the CENTER of the galaxy. So when a star near the center explodes and sends off cosmic rays, those cosmic rays would kill off all the life on any planets that happened to be orbiting nearby stars."**

***Point to a spot 2/3 of the way out from the center of Andromeda.***

- **"So if this were a photograph of the Milky Way, our Solar System would be located about HERE. . ."**

**Q: "Does that seem like a good spot to you?"** [Let them discuss.]

- **"Let's pretend this QUARTER is our Solar System, with the Sun in the middle all the way out to the last planet."**

**Q: "What is the name of the most distant planet in the SOLAR SYSTEM?"** [NEPTUNE. In 2006, scientists decided that Pluto was a "dwarf planet", not a regular planet.]

***Rotate the quarter, like it is the solar system turning.***

**Q: "So if this were the Milky Way Galaxy. Our Milky Way would be about here. Do you think it would be rotating like this, in the same way as Andromeda rotates . . .?"**

***Hold the quarter and have it rotate like it were in the same flat, angled plane as Andromeda.***

- **"Actually, our Solar System sits inside the Milky Way more like this . . ."**

***Hold quarter perpendicular to the plane of Andromeda — exactly the opposite way that you would think it would go, then slowly move the quarter in a cycle around the flat disk part of the galaxy and say:***

- **“Did you know that our Solar System is orbiting like this inside the Milky Way? . . . Very slowly. . . It takes 200 million years for the Sun to make one complete orbit around the center of the Milky Way.”**

- **“So Earth orbits the Sun . . . and the Sun orbits the Black Hole in the center of the Milky Way!”**

[FYI to teacher: Notice that you if you rotate the quarter, there are times of the year when the planets would look toward the center of the Milky Way at night (looking away from the Sun) and at the opposite time of year it looks toward the outer edge of the Milky Way. Those times are SUMMER for the Northern Hemisphere (looking into the dense center) and WINTER (looking outward toward the outer edge). So those are the 2 times of the year that we see the Milky Way. In spring and fall, our Northern Hemisphere is looking perpendicular to the plane of the galaxy, like looking straight upward or downward through the thin disk of the Milky Way. So we can't notice a cluster of Milky stars. This means Summer and Winter are the best times to view the Milky Way on a skywatch.]

## **PART 2: ANDROMEDA GALAXY**

***Show Andromeda Galaxy photo***

**Q: “Okay. So we have pretended that this is a photograph of our own Milky Way galaxy. But what is it really?”** [Andromeda]

- **“Andromeda! The Andromeda Galaxy is our closest neighbor galaxy. Even so, it is a long, long ways away. It is 2 and a half million light-years away.”**

***Show the NUMBERS chart and identify “MILLION”.***

**Q: “Does anybody know what a LIGHT-YEAR is?”**

- **“A LIGHT-YEAR is the distance that light travels in one year.”**
- **“A light year is a huge distance. Consider this: Earth is 93 million miles from the Sun. It takes a ray of sunlight 8 MINUTES to zoom all**

the way from the surface of the sun to our planet. So light travels 93 million miles in 8 minutes."

Q: "So if light travels 93 million miles in 8 minutes, do you think a ray of light would travel more than a billion miles in a whole year?"

*Show the NUMBERS chart and identify "BILLION".*

- "Actually, light travels way more than a billion miles in a year. Light travels about 700 TRILLION miles in a year. So something located one light-year away from Earth is about 700 TRILLION MILES away."

*Show the NUMBERS chart and identify "TRILLION".*

Q: "Are there any stars that are less than 1 light-year away from our solar system? That means: Are there any stars less than 700 trillion miles away?"

- "The only star that close is the SUN itself! And the Sun is only 8 light-minutes away from us. So the closest neighbor star is way, way far away. Actually, the closest star is ALPHA CENTAURI, and it is about 4 light-years away. So light from Alpha Centauri takes 4 years to reach Earth."

- "All the stars within our own galaxy, including the star Alpha Centauri, are less than 100,000 light years away from us. But the nearest GALAXY that is our neighbor is Andromeda, and it is TWO AND A HALF MILLION LIGHT YEARS away."

Q: "Do you think humans will ever be able to travel to the Andromeda Galaxy?" [Let them discuss; there is no right answer.]

Q: "Would you want to go there? . . . Why or why not?" [discuss]

- "Now here is another AMAZING thing about this photograph of the Andromeda Galaxy: This is a photograph of how Andromeda looked 2 and half billion years ago. Nobody can take a photograph of how it actually looks today. It would be like me snapping a photograph of all of you sitting in this room right now, but when we actually looked at the photograph, you would all look like BABIES! So this is very strange."

Q: "How could this be? Why can't any telescope take a photograph of how Andromeda actually looks today?" [Let them guess for awhile]

## **ACTIVITY: Dinner plate demonstration**

Recruit **2 children** to hold the dinner plates. Send them to opposite ends of the room. Then continue the dialogue:

- **"Both of you: Hold out your dinner plates, because each of them is going to represent a spiral galaxy."**
- [Point to one child.] **"Your dinner plate represents the ANDROMEDA GALAXY. Andromeda is a SPIRAL GALAXY, so a dinner plate is kind of the same shape."**
- [Point to the other child]. **"Your dinner plate is our own MILKY WAY GALAXY."**
- **"And because the galaxies are so huge, this is about how far away they would be from one another if they were both shrunk down to the size of a dinner plate."**
- **"So this means that the distance between the two of you represents 2 and a half MILLION light years — which means *gazillions of miles!*"**

**Q: "Who would like to play the role of a BEAM OF LIGHT?"** [recruit]

- [Instruction] **"Okay. You go stand right next to Andromeda."**
- **"In the real Universe, it would take you, as a Beam of Light, 2 and a half million years to travel from your home star, Andromeda, all the way over to the Milky Way."**
- **"Photographs happen when light touches a photographic plate that is sensitive to light. So, Beam of Light: Please start walking really slowly toward the Milky Way."** [Tell her/him to slow down if you need to; make sure they don't get there yet.]

**Q: "Now, who would like to play a SECOND beam of light?"** [recruit]

- [Instruction] **"You go stand by Andromeda and get ready to begin your own journey toward the Milky Way."**
- **"Okay. Let's ask our First Beam of Light to walk a little faster so that they are just about ready to touch the plate of the Milky Way. This mean our Beam of Light is just about ready to reach a telescope on Planet Earth that is going to take the photograph of Andromeda."**

- **"But first, let's get our Second Beam of Light walking toward the Milky Way, too. . . Begin to walk very very slowly."**
- **"Okay. Beam Number 2 represents light leaving Andromeda right now today."**
- **"What about Beam Number 1 that is just about ready to touch the photographic plate in the telescope on Planet Earth in the Milky Way Galaxy? Go ahead and touch the dinner plate. . . Snap! The photograph is taken."**
- **"Beam Number 1 must have begun its journey 2.5 million years ago, because it had to travel 2.5 million light years to reach our galaxy. So the telescope will record what Andromeda looked like 2.5 million years ago — not the way it looks today. Because the way it looks today is Beam Number 2, and Beam Number 2 is just beginning its journey; it is nowhere close to touching down on Planet Earth."**
- **"Okay, thank you, Light Beams! Both Light Beams can go and sit down. Andromeda and Milky Way: Please stay where you are! We haven't finished with you yet."**

***Point to Andromeda Galaxy PHOTO.***

- **"So when we look at this photograph of Andromeda Galaxy, which was taken just a few years ago, we are really LOOKING BACK IN TIME."**
- **"Telescopes are TIME MACHINES!"**
- **"Isn't that cool?!!!! Scientists discovered this amazing fact."**
- **"Now here is something else that is exciting: Andromeda and the Milky Way are actually moving TOWARD ONE ANOTHER!"**
- **"Let's have our two galaxies start moving toward one another. . . but very very slowly."**
- **"They are moving toward one another a lot more slowly than a light beam can travel. Scientists estimate it will take maybe 3 BILLION YEARS for the two galaxies to meet."**
- **"And when they meet, they will begin to MERGE into an even larger galaxy. But the stars are so far apart in each galaxy that almost no stars will CRASH into one another. So our SUN should be okay,"**



although it will be tossed around a bit. But Earth and the other planets will stay safely in orbit around the Sun, no matter where the Sun may be moved to.”

- “Andromeda and the Milky Way are as big as they are because they have been EATING up smaller galaxies in the 14 billion years since the Universe began. So MERGERS like the one to come are all part of the process.”

### **PART 3: ARCTURUS, THE ALIEN STAR**

- “So spiral galaxies grow big by eating smaller galaxies. Let’s look at the Andromeda photograph again.”

*Show Andromeda Galaxy PHOTO again. Point to the small oval smudge in the lower right.*

- “This smudge is not part of Andromeda. It is a small neighbor galaxy to Andromeda, and it is quite likely that Andromeda will consume it at some point.”

- “Our own Milky Way has several SMALL COMPANION GALAXIES around it, too. Now, here is something cool: Recently, scientists were studying how stars within our own galaxy move relative to one another. Most are going around the disk, like TOY HORSES go around a merry-go-round. That’s the way our Sun moves, too.”

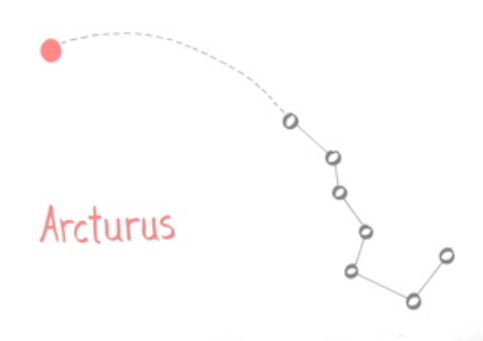
- “But there is one star that is really easy to see that is part of a cluster of much dimmer stars, and this whole CLUSTER is moving in the OPPOSITE direction! Something is strange. So scientists figured out that the Milky Way recently ATE that cluster of stars, when its gravity pulled in a very small little galaxy. And those stars haven’t yet adjusted to the movement of the rest of the stars.”

- “What that means is that those stars are ALIENS to our galaxy. They are really from another smaller galaxy, but they have been sucked into ours.”

- “The only star in this cluster that we can see with our own eyes at night is this star:”

*Point to Arcturus (red) on the chart of Arcturus and the Big Dipper, downloadable at:*

<http://thegreatstory.org/charts/hi-res-photos-stardust.html>



- **"Arcturus!"** Arcturus is easy to find, because first you find this constellation [point]

**Q: "What is this constellation?"** [The Big Dipper]

- **"The Big Dipper. . . So you follow the curve of the handle and the first bright star you get to, which is red, because it is a Red Giant star, is Arcturus. Some people remember how to do this because another name for a curve is an "arc". So they say, "Arc to Arcturus from the handle fo the Big Dipper."**
- **"ARCTURUS is the alien star that we can see. It was part of a very small galaxy that was recently gobbled up by the Milky Way."**
- **"So if anybody every asks you if you have seen a space alien, tell them that you have, and you know its name: It is the star Arcturus!"**

**ACTIVITY:** Find Arcturus in the Night Sky

[Encourage kids to find Arcturus on their own, or schedule a Sky Watch night, with the other Lesson activities for Sky Watches.]

## **PART 4: THE DISCOVERY OF ANDROMEDA**

**Show Andromeda Galaxy PHOTO again.**

- **"Now here is some interesting HISTORY: A hundred years ago, the world's best scientists thought that the entire Universe was just what we now call the Milky Way Galaxy. They thought that there**

**was absolutely NOTHING beyond our own galaxy. They couldn't see any farther because they didn't have powerful enough telescope."**

- **"But in 1924, EDWIN HUBBLE (the Hubble Space Telescope was named after him) pointed a new telescope at ANDROMEDA, which had up till then looked like a hazy CLOUD inside our Milky Way."**

- **"Well! With this new telescope he could see that Andromeda was no cloud: He could see spots of light coming from ACTUAL STARS within Andromeda — just like we can sit here and see actual stars inside Andromeda, because this photograph is so clear."**

- **"Then Edwin Hubble MEASURED the dimness of the light of particular kinds of stars within Andromeda that always shine the same way, no matter what galaxy they are in. The farther away a star, the DIMMER it looks. So he could calculate how far away those stars were inside of Andromeda."**

- **"To his amazement, he calculated that those stars were 2 and a half million light years away. And this made him conclude that they were all part of a SEPARATE GALAXY. Andromeda was a galaxy of its own! Now the Universe had 2 galaxies in it!"**

- **"Edwin Hubble became very CURIOUS. He wondered whether there might be even more galaxies in the Universe. So he pointed his powerful telescope at some other cloudy features in the night sky. He discovered that these also had little stars shining in them, so they were separate galaxies, too."**

- **"Suddenly, scientists realized that the Universe was a WHOLE LOT BIGGER than they had thought it was before!"**

- **"So think about this: When your great-great grandparents were born, nobody in the whole world knew that the Universe was any bigger than our own Milky Way Galaxy. . .**

**Q: "NOW how big is it? . . . How many galaxies do scientists think exist in the Universe?"** [Let them guess]

## **PART 5: HUBBLE DEEP FIELD PHOTOGRAPHS**

***Show the HUBBLE DEEP FIELD photo.***

- “This is the photograph that makes YOUR generation so much different from mine, because this is your Universe. This is the Universe you were BORN into. It is much bigger than the Universe I was born into. Let me explain:”
- “The Hubble Space Telescope took this photograph in 1995. It is called “THE HUBBLE DEEP FIELD PHOTOGRAPH.” Except for a couple of obvious STARS, every single spot on this photograph, including the tiniest ones, are all individual GALAXIES, but galaxies that are very, very far away.”
- “The amazing thing about this photograph is HOW MANY GALAXIES THERE ARE IN IT!”
- “It took the Hubble 10 days of looking at one tiny spot in the universe to gather enough photons of light to take this picture. And it represents just a tiny piece of the sky: no bigger than what you would see if you had an 8-foot long straw, like you drink through — an 8-foot long straw that you put up to your eye and looked through that. That is the size of the sky that the Hubble photographed.”

***Pass out the drinking straws and have the kids look through them.***

- “Now if the straws you are holding right now were a whole lot longer, you would see even less. That’s how small a piece of Outer Space the Hubble looked at and took this photograph from.”
- “Scientists COUNTED the number of galaxies in this one photograph, and then they mathematically CALCULATED how many galaxies would be in the whole universe if the rest of the sky were as densely populated with galaxies as this little piece of sky is . . .”

**Q: “Do you know HOW MANY GALAXIES they calculated must exist in the Universe?”** [let them guess]

- “About A HUNDRED BILLION GALAXIES!”

***Show the NUMBERS chart and identify “BILLION”.***

- “So, in the short amount of time since your great-great-grandparents were born, our idea of how big the Universe is has

**grown from 1 GALAXY TO 100 BILLION GALAXIES!"**

**Q: "How does that make you feel?"** [Let them discuss.]

- **"Well, how do we know that the Universe actually has that many galaxies? I mean, maybe the Hubble just happened to point to a spot in the sky where galaxies were really numerous, and maybe the sky is vacant elsewhere?"**
- **"Scientists wondered that too, so several years later, they pointed the Hubble at a different spot. . . . But they counted just as many galaxies in that spot too."**

[FYI: The first Deep Field photo, taken in 1995, is called "Hubble Deep Field North", because it was pointed north in the night sky. The 1998 photo made to confirm that the Universe really does have a lot of galaxies all over it was pointed toward the south, so it is called "Hubble Deep Field South."

- **"Finally, in 2004 scientists pointed the Hubble Space Telescope at another spot in the sky, and instead of capturing photons of light from the same spot for 10 days, they had the Hubble capture photons of light for 3 whole months! This meant that the photograph would show even fainter galaxies — galaxies even farther away."**

***Show the HUBBLE ULTRA DEEP FIELD photo.***

- **"Here is what they discovered in the photograph they took in 2004: It is called "THE HUBBLE ULTRA DEEP FIELD" photo, because it reveals galaxies even farther away than in the original "HUBBLE DEEP FIELD" photo."**

***Compare the HUBBLE ULTRA DEEP FIELD photo with HUBBLE DEEP FIELD.***

- **"The HUBBLE DEEP FIELD photo taken in 1995 shows galaxies that are not only very far away, but very young. Remember, you can't see anything in the night sky as it is right now. The farther away it is, the farther BACK IN TIME we are looking. So scientists calculate that some of the tiniest spots of galaxies in this photo were how galaxies looked 9 or 10 billion years ago!"**
- **"We have no idea what those same galaxies look like today. In fact, a lot of them have probably been GOBBLED up by their neighbors!"**

- **"And when we look at the more recent photo, the one that the Hubble Space Telescope took in 2004, we see even farther back in time: *We are looking back 12 and 13 billion years!*"**
- **"If the Universe was born 14 billion years ago, during the BIG BANG or the Great Radiance, then when we look back 13 billion years, we are looking back almost to the beginning!"**
- **"Truly, the Hubble ULTRA Deep Field photo is a BABY PICTURE of our Universe! . . . Isn't it cute?!!!!**
- **"But again, think about how BIG the Universe is. This Universe contains a hundred BILLION galaxies — each of which contains maybe a hundred BILLION stars. . . . And here YOU are: sitting in a classroom situated on one PLANET orbiting a single star in a GALAXY that holds 100 BILLION stars — in a UNIVERSE that contains 100 BILLION galaxies."**

**Q: "How does that make YOU feel?"** [Let them discuss for awhile.]

- **"Well, I don't want to send you home feeling small. So I will tell you about how some scientists think about who we EARTHLINGS are in this vast Universe. Here is what they say."**
- **"Yes, in one sense HUMANS are just a tiny fragment of a gigantic Universe. But we are very important, too. Because, if we humans didn't exist, WHO WOULD BE LOOKING AT THE UNIVERSE RIGHT NOW? Who would be looking at photographs of stars and galaxies right now and talking about the Universe?"**
- **"Maybe there are ALIEN life forms somewhere else in this galaxy or in another galaxy who are doing that, too. But we are the only ones that scientists have ever seen. And that means that we can think of ourselves in a very special way:"**
- **"Look at these photos again right now. . . . And think of yourself this way:"**
- **"YOU ARE THE UNIVERSE looking at its own BABY PICTURES!"**
- **"Yes, you! You are not separate from the UNIVERSE. You are a piece of the Universe that has evolved to a point where it can admire its own baby pictures: these photographs right here!"**
- **"Your EYES are the eyes through which the Universe can see**

itself.”

- “Your **EARS** are the ears by which the Universe can listen to the **STORY** of its own beginnings, as you are doing right now!”
- “Humans have evolved within the Universe, kind of like an **ACORN** grows on the branch of an oak tree, or an **APPLE** grows on a branch of an apple tree. We are a piece of the Universe. We are the piece of the Universe that can **ENJOY THINKING** about how big and old the Universe is, and that can enjoy looking at its own baby pictures.”

**Q: “NOW how do you feel? Do you maybe feel a bit bigger, a bit more important?”** [Let them discuss.]

### **POSSIBLE ACTIVITIES:**

- **ACTIVE:** Play an audio of “**The Galaxy Song**”, by Monty Python. Encourage the kids to get up and dance, and you dance too. You can listen to this song for free, and see the text of the lyrics, at:

[http://www.gecdsb.on.ca/d&g/astro/music/Galaxy\\_Song.html](http://www.gecdsb.on.ca/d&g/astro/music/Galaxy_Song.html)

*Note:* Some kids might enjoy memorizing the lyrics, so you might want to pass out copies of the lyrics for the kids to take home. Also, this way they have something to share with their parents.

- **PASSIVE VIEWING** – Here are some recommended YouTube videos

The Hubble Deep Field in 3-D:

[http://www.youtube.com/watch?v=oAVjF\\_7ensg](http://www.youtube.com/watch?v=oAVjF_7ensg)

The Known Universe by AMNH:

<http://www.youtube.com/watch?v=17jymDn0W6U>

The Stars and the Grand Universe:

<http://www.youtube.com/watch?v=2LLfDG0GNvc>

SONG: Carl Sagan, “A Glorious Dawn”:

<http://www.youtube.com/watch?v=zSgiXGELjbc>

Neil DeGrasse Tyson sermon “Kinship with the Cosmos”:

<http://www.youtube.com/watch?v=wt7RntAnqDA>

Carl Sagan Apple Pie: <http://www.youtube.com/watch?v=MSce39QSYVo>

**Supplemental ACTIVITY:** Ask the children to bring in **BABY PICTURES** of themselves for your next meeting. Then, they can use removable tape to stick the photos onto the big poster of the HUBBLE ULTRA DEEP FIELD. You can have them create labels to stick on too, for example: "Sarah, 14 billion and 3 months old". Make a big center label for the Universe photograph itself: "Our Universe at 1 billion years old."

Note: So long as you have laminated the Hubble photo, you can have stuff taped onto it without any damage.

Post the completed collage in a place where the whole congregation can see it. Photograph it. Eventually, return the baby pictures to the children to take back home.





## **Supplementary Lesson D:**

# **"Stardust Christmas Song"**

Stardust Curriculum by Connie Barlow  
September 2007

**TheGreatStory.org/stardust-kids.html**

<http://thegreatstory.org/songs/SilentNight.html>

*NOTE: This "stardust" version of Silent Night was first used by Connie at the December 21, 2003, intergenerational Sunday service of the Unitarian Universalist Fellowship of Clemson, SC. For each verse, the first and last lines are always the same:*

FIRST LINE: Silent night. Holy night. All is calm. All is bright.

LAST LINE: Life abounds upon Earth. Life abounds upon Earth.

1. PLAN-ets GRACE-ful-ly CIR-cle the SUN  
STAR-dust CY-cles through EV-er-y ONE
2. RA-di-ant BEAMS from PRI-mor-dial STARS  
CLUMPED in-to PLAN-ets like VE-nus and MARS
3. CAR-bon, NI-tro-gen AND cal-ci-UM  
ALL were BORN in-side AN-ces-tral SUNS
4. DEATH and re-CY-cling of MILL-ions of STARS  
BROUGHT forth PLAN-ets and ALL that we ARE.
5. SIL-ver, GOLD, and TI-ta-ni-UM  
FORGED in STARS be-fore EARTH had be-GUN.
6. FLAR-ing FORTH a-cross HEAV-en a-BOVE  
SU-per-NO-vas made ALL that we LOVE.

## **Suggestions for Creative Activities with this SONG:**

### **1. Teach the Song for singing at a Christmas event.**

For UU or Christian congregations, make sure you begin with the original first verse of "Silent Night", so that it is respectfully integrated into the Christmas event.

*Suggestion: Invite the audience to sing the beginning and end lines, once they pick it up, and then just listen to the children for the in-between lines. Or do an INTERGENERATIONAL event, in which all are singing together. Ideally, you would project the words up front onto a big screen, so that all voices are uplifted. (Make sure you use lovely Hubble photographs as the background for the slides, dark enough for the words to easily show.)*

### **2. Recruit children who would like to dance or drum at the singing event.**

You could stage a sing-along performance, as above, and have children who volunteer to be dancers to dance the song on-stage. Recruit an adult volunteer who knows ballet to teach this dance step: *Pas de Bouree* (PAH de boor AY). This is the only step they need to learn! Encourage the kids to move around spontaneously while they do this waltz-like step: 1 - 2 -3, 1 - 2 - 3, rather than have them stand in a boring line facing the audience. They could swing gauzy scarves of Christmas colors while they dance. Costuming would be glittery. Kids who are good with percussion could be trained to accompany the singing (and the piano) on drums, as the beat is simple and fun to learn. Or, just offer kids the opportunity to learn the dance and drumming (they can all try to drum on tables first) in class just for their own enjoyment or to perform for their families at home.

### **3. Children write their own verses to the song.**

Give children the thrill of creating their own verses. Some children may easily be able to create rhyming lines that match the rhythm without any special help. Others may need some guidance; others may never be able to do it. Children who are not interested in songwriting or who become frustrated might be trained to drum out the beat, or be encouraged to draw the scenes that other kids are creating in words.

If you choose this activity, teach the kids *only the first verse*. Then do a brainstorming as a class together to come up with fun key words from all the stardust lessons. Bring out the photographs and charts to give them visual prompts to remember key words, such as:

supernova, Red Giant stars, Big Blue stars, White Dwarf, Black Hole, atoms, carbon, oxygen, helium, hydrogen, calcium, Arcturus, Betelgeuse, planets, Earth, Venus, Jupiter, Mars, Saturn, atoms, galaxies, the Sun, ancestor stars, ancestral suns, circle of life, birth and death of stars, light-years away, Andromeda, Milky Way, the Universe, Great Radiance, Big Bang

## GUIDANCE FOR SONG-WRITING

If you yourself don't find singing and songwriting to be playful and fun, then recruit a volunteer to teach this session — but someone who won't be overly professional and serious about it. Here are some possible approaches:

- Teach children to sing and clap out the basic beat, with CAPITALS as the syllable that get the emphasis:

**LONG short short LONG short short LONG short short LONG short short**  
PLA                nets GRACE ful        ly        CIR        cle        the        SUN

**LONG short short LONG short short LONG short short LONG short short**  
STAR                dust        CY        cles through EV        er        y        ONE

*Note: The way "Silent Night" is normally sung is syncopated, with the 1-2-3 beat having a longer 1 and shorter 2 and 3. A traditional waltz is a 1-2-3 in which all three notes are the same length. "Silent Night" can also be sung like a waltz, but it is less lively that way.*

- For the list of KEY WORDS the class created together, have the kids figure out which syllables of each word are emphasized, and write them out again for all to see, such as:

SU-per NOV-a        JU-pi-ter        VE-nus        an-DROM-e-DA or AN-drom-e-DA

- Now have them see how to make each word or phrase fit the beat. Help them see that those spots can happen in different parts of the full line above (which always has 4 emphasized beats in it), so each word or term can go in several different places.

**Supernova:**                **LONG short short LONG short**  
SU                                per        NOV        a

**Jupiter:**                **LONG short short**  
JU        pi        ter

**Venus and Mars:**                **LONG short short LONG**  
VE        nus        and        MARS

**Red Giant stars:**                **LONG short short LONG**  
RED        gi        ant        STARS

**Big Blue stars:**                **LONG short short LONG**  
B        IG        blue        STARS

**ancestor stars:**                **LONG short short LONG**  
AN        cest        tor        STARS

**our universe:**                **LONG short short LONG**  
OUR        u        ni        VERSE

*Note that on "our universe" we chose to not emphasize the "U", but it still sounds okay. So there is a lot of flexibility in how you do this.*

For EACH NEW VERSE, the kids need to **create only two sentences**, because

The **FIRST LINE** is always:

Silent night. Holy night. All is calm. All is bright.

And the **LAST LINE** is always:

Life abounds upon Earth. Life abounds upon Earth.

The easiest way to begin to create 2-sentence pairs is like this:

1. **Choose a term** that you like (such as, "Universe" or "Red Giant Star").
2. Brainstorm (alone or as a class) how you might include that word in a **meaningful sentence**.
3. Now **try to write that sentence** so that it kind of matches the *LONG-short-short* beats of the song. Where do the words not match the beats? Where might you shorten or lengthen the sentence to work? Or what words might you substitute to make it sound better? Notice that the sentence must have a total of **4 emphasized syllables**. Don't yet worry about what comes next. Just make that first sentence interesting and make sure it is easy to sing.
4. Next, notice what the **last syllable** of that sentence is. It will be the 4<sup>th</sup> and final emphasized syllable.
5. Begin to work on **the second sentence** this way: First, **brainstorm as many rhyming words** as you can think of that will rhyme with the way the first sentence you created ends. So you need to find words that rhyme with the final syllable of the first sentence you just created. Make a **list** of all the possible rhyming words you can think of.
6. **Choose the rhyming word or words** that look like they might be easiest to work with, as one of them will become the last word in the second sentence you create. The rhyming word should be simple enough so that there are lots of different ways to write a meaningful sentence that ends in that word.
7. How might that rhyming word **relate in a meaningful way** to the FIRST sentence you already created? (This is where the imagination should be encouraged to run wild!)
6. Settle on one or two different **concepts for the second sentence**, that will make sense when you use the rhyming word to end the second sentence.
7. Now try to **shape the concept** into a second sentence in which the **words actually fit the beats of the song**. If you can't quite do it, try to imagine a different concept. Or choose a different rhyming word to end your second sentence, and begin the imagining process again. Have **fun** creating!



## SKY WATCH / SLEEPOVER

Stardust Curriculum by Connie Barlow  
September 2007

[TheGreatStory.org/stardust-kids.html](http://TheGreatStory.org/stardust-kids.html)

### SKYWATCH ACTIVITIES (outdoors):

Incorporate any of these activities for Skywatches that have been suggested in previous modules:

- **Breathing with Red Giants** - Lesson 4
- **Ancestor Stars** - Lesson 6
- **Arcturus, the alien Star** – Supplementary Lesson C
- **Birthday Stars** - Supplementary Lesson A
- **Feeling Earth's Orbit Around the Sun** (new activity, see below)
- **What did our human ancestors believe?** (new activity, below)

*Preparation:* Download instructions and a skymap for where the stars are in the early evening for that time of year. Recruit one or more astronomy buffs to help you with this and to assist you at the Skywatch event. Make sure that you know which PLANETS will be visible, too. Have available any relevant CHARTS from the Lesson plans pertaining to each activity.

*Warning about the moon:* Do not schedule the Skywatch when the moon is bright in the evening because a bright moon makes it difficult to see the stars. This means you can schedule a Skywatch any time 3 days after a full moon or later, or any time at least 10 days before a full moon.

### **OTHER POSSIBLE ACTIVITIES (indoors):**

- **Sing “Twinkle Twinkle” with new Verse** – Lesson 4
- **Sing “Stardust Christmas Song”** – Supplementary Lesson D
- **Spend time learning the Monty Python “Galaxy” Song** – Supplementary Lesson C
- **Introductions by name and “Cosmic Age”** – Lesson 1
- **Watch the Lion King movie** – Lesson 2
- **Perform the Startall Parable** – Supplementary Lesson B
- **Cosmic Communion Ceremony** – Lesson 8
- **Feeling Earth’s Orbit Around the Sun** (new lesson, below)
- **What our human ancestor’s believed** (new lesson, below)
- **Pluto’s Identity Crisis: A Parable** (new lesson, below)

### **YouTube short Videos to view indoors**

If you have a **laptop and high-speed internet connection and a digital projector**, you can watch and discuss the short videos (some of them music videos and some of them sing-along!). Suggested videos are at the bottom of this page:

<http://thegreatstory.org/stardust-kids.html>

Also, **the entire COSMOS series by Carl Sagan** is now available for free online viewing on Hulu.com. There you can choose episodes ahead of time:

<http://www.hulu.com/search?query=Cosmos&st=1>

## **NEW Outdoor ACTIVITY for SUNSET**

### **Feeling Earth's Orbit Around the Sun**

Note: This activity must be done outdoors when you can still see the sun on the horizon just before **SUNSET**. Ideally, Venus, Jupiter, or another of the bright planets (Saturn, Mars) would be visible in the sky, too, right after sunset.

**Materials:** a small ball or a spherical fruit to serve as Earth, with a mark on it to suggest where we stand right now. A larger ball or spherical fruit to serve as the Sun. A CD (or DVD) disk.

**SUGGESTED DIALOGUE** (begin outdoors in a clearing):

**Q:** "Let's all stretch out our arms. . . . Now pretend that you are Earth spinning in its orbit. . . . Okay, now who can **SHOW with your body the direction that Earth ACTUALLY spins?**" [Nobody ever gets it right on first try, so let them struggle, and just keep saying no. Read below to know what is correct.]

- "Here is a **CLUE**: Look at where the Sun is right now, and try to figure out what the Earth is doing."

- "Here is another **CLUE**: Before there were telescopes, people thought that the Sun actually was moving. They thought that the Earth stood still and that the Sun moved in a circle around the Earth, going behind the Earth at night and emerging around the other side in the morning."

**Q:** "Is that what really happens?" [Let them discuss]

- "Here is how we can figure this out. Let's all stand still and face the horizon where the Sun is going to set."

**Q:** "If the Sun is actually **STANDING STILL** and it is Earth that is moving instead, **WHICH WAY** is Earth moving? . . ."

- "Let's all **LEAN BACKWARD** a bit, without falling. That is the direction that Earth is turning."

- **"So let's IMAGINE that we are all standing on the back of a great WHALE. . . . The whale is resting on the surface of the ocean and we are standing on its back. . . The HEAD of the whale is behind us, and its TAIL is in front of us, toward the sun. All is calm and steady, calm and steady . . ."**

- **"Now, the whale is going to begin to dive very slowly. . . ."**

**Q: "Do you find yourself leaning backward as the whale begins to slowly dive?"**

- **"Okay, before we all fall into the water, let's turn the whale back into Planet Earth. We are standing right here on Planet Earth and the Earth is rotating AWAY from the sun. That's what makes it look like the Sun is going down, even though the Sun really isn't moving at all."**

**Q: "Can you imagine the Earth rotating away from the Sun, right now, as the Sun seems to be moving closer to the horizon? . . . Can you feel inside your body that the Earth is rotating backward behind us, and that the Sun is actually standing still?"** [Keep playing with this image until the kids seem to feel it.]

***Use the 2 spherical props (balls or fruits) to show how the Earth is moving. Have somebody hold the Sun prop, aligned with the Sun. Then ask a volunteer to hold the Earth prop (but first place a sticker or some mark on it to show where we are on Earth). Then ask the volunteer to make the Earth prop rotate in the correct direction (away from the sun). Watch the marker move away, backward.***

- **"So if that is really how the Earth is moving right now, but very slowly. Let's all put out our arms again and see if we can get the movement right this time. . . ."**

**Q: "Show how the Earth is turning. . . ."**

[Wait for someone to do it correctly and then point excitedly to them, saying]

- **"Yes! That's it! Your arms should rotate STRAIGHT UP AND DOWN, so you have to bend at your waist and try to turn. . . . Make sure your HEADS are all pointed to the NORTH the whole time you are doing this."**

**Q: "Where is North?"**



**Q: Can somebody explain why North is always easy to find at sunset?"**

- "Okay. . . . Good! . . . Now, let's try to feel something else. Let's try to feel the shape of the solar system. . . .

- "At the same time that Earth is **ROTATING** away from the Sun at sunset, it is also **ORBITING** the Sun in a big circle around the Sun."

***Use the 2 spherical props (balls or fruits) to show how the Earth is both rotating and REVOLVING around the sun at the same time.***

- "Let's do an experiment: Let's all stand in a large **CIRCLE**. . . . Now let's all start **WALKING** around the circle in this direction."

[Walk to the right, so that it is counter-clockwise. . . Let them walk a bit.]

- "Good, now while you keep walking around the circle, imagine that you are Planet Earth, and your walking around the circle is just like Earth orbiting the Sun. Let's put our Sun ball in the center of our circle to show that. . . ."

***Place the Sun ball into the center of the circle.***

- "Good. Now, while we keep **ORBITING** the Sun, let us add in the other movement that Earth is doing. Earth is also **TURNING ON ITS AXIS** (remember, the North Pole is your head). The Earth is turning on its axis 365 times for every circular orbit it makes around the Sun. Each little turn signifies one **DAY** and **NIGHT** cycle. So you have to spin pretty fast, while you slowly keep walking around the Sun." [Let them do this for awhile.]

[You should notice that most kids automatically spin in a counter-clockwise direction. It is really hard to walk an orbit counter-clockwise while spinning clockwise.]

- "STOP! . . . Let's all stand in our big circle quietly, while I ask you to do the next thing . . . ."

- "I want you to start **WALKING** in the same direction you were walking in before, so you will keep your same **ORBIT**. But now I want you each to try to **SPIN** in the **OPPOSITE** direction from what you were spinning in before — while you keep walking."

**Q: "STOP! . . . Is it harder or easier to spin that way?"** [Listen to all the responses.]

- **"So let's walk the circle again. This time, EVERYBODY spin in the direction that is EASIEST for you to spin in while you keep walking in this circle."**

- **"Stop! . . . Let's all stand quietly in the circle."**

**Q: "Who found it easiest to turn toward their LEFT SHOULDER, like this? . . . Who found it easiest to turn toward their RIGHT SHOULDER like this? . . ."**

[Note: For an orbit that circles counter-clockwise, as you have been doing, it is easier to spin toward the left shoulder. *But don't make the students who spin toward the right wrong; they may be strongly left-handed or not sensitive enough to have felt the difference in spins.*]

- **"Most people find it easiest to turn toward their left shoulder when we are walking this way in the circle. . . So let's do another EXPERIMENT. Let's find out which way feels easiest to spin while we orbit the sun in the OPPOSITE direction. . . That means we all need to begin to walk around the circle in the OTHER direction, clockwise."**

- **"Keep walking slowly around the circle. . . Now choose to SPIN in whichever direction feels EASIEST for you . . ."**

- **"STOP!"**

**Q: "Did you find it was EASIEST TO SPIN in the OPPOSITE direction from what you had been spinning in when we were walking the circle in the other direction?"** [Let them respond.]

**Q: "So here is a question for you: Do you think the EARTH is also spinning in the easiest direction?"** [Let them respond.]

- **"Let's find out. . . Okay, find a spot of ground where you can bend over at the waist and stretch your arms out, and so that your head is pointing NORTH . . ."**

- **"Start slowly spinning the way the Earth is spinning— away from the setting sun. . ."**

**Q: "Who can show us with their arms how they think Earth ORBITS the sun? Remember, when we spin that is just the day-night cycle. Now we want to see the path that Earth takes over the course of one year. . ."**

- **"Here is a clue: All the planets follow in the same circular shape for their orbits too, as if they are all stuck onto the surface of a CD or a DVD disk that is spinning. . ."**

***Pull the CD disk out of your pocket and move your finger around it, like a planet orbiting, with the hole in the center being the Sun.***

**Q: "Does anybody see a planet yet in the sky?"**

[Rarely will any child know whether a bright light is a planet or a star, because WHERE each planet is in the sky is always changing. So make sure that you know in advance which planets may be visible in the early evening and where exactly in the sky. Recruit an adult astronomy hobbyist to help you.]

***Show them where any visible PLANET is, and make sure to ask whether each planet is closer or farther from the Sun than we are.***

***If you see JUPITER or SATURN in the WESTERN sky near sunset, those outer planets may look closer to the sun, but they cannot be. Rather, they are on nearly the opposite side of the solar system from us right now, with the Sun in between us. If you see one of those planets overhead or toward the EAST at sunset, then you can easily imagine them being in the same part of the CD disk as we are now. Orient the CD disk to try to show that.***

***If you see VENUS (it will always be near either the East or West Horizon), ask the children whether they think VENUS can every be overhead. The answer is NO. Ask whether anyone can guess why. [Use the CD disk to try to show that any planet CLOSER to the sun from us cannot possibly ever be overhead when we Earthlings look at the night sky.***

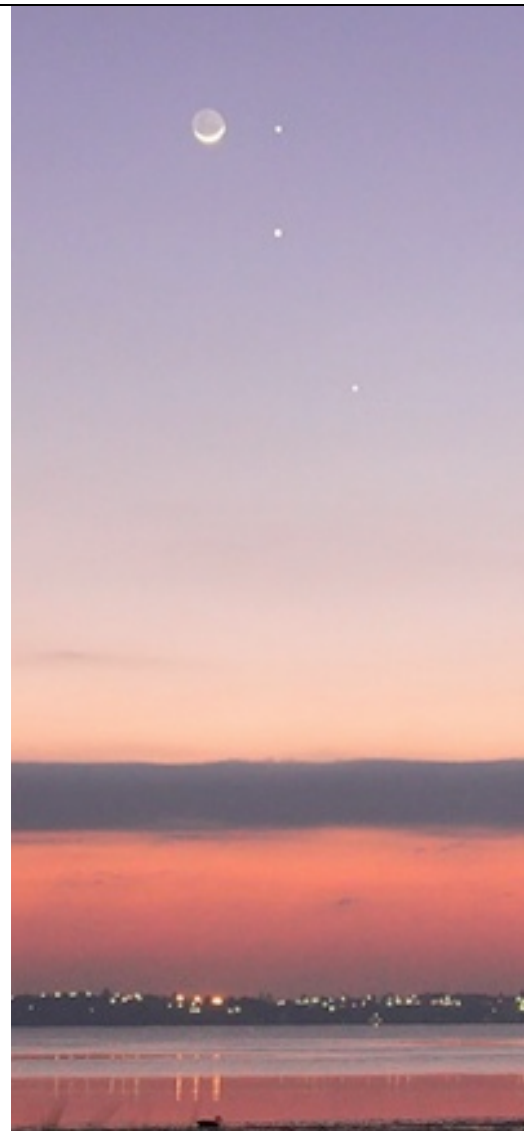
- **"Can you imagine that that planet [NAME] is traveling in the same flat disk of our solar system that Earth and all the other planets are traveling? . . . This means that as you bend over and spin like planet Earth, try to have your outstretched arms, one at a time, pass right by that planet. We are all on the same flat disk of the solar system. That will help you get Earth's own orbit around the sun at the correct angle. The Moon is revolving around the Earth on that same flat surface of a Solar System disk, too, though not exactly."**

[Walk among the kids to help each get their arms angled properly, kind of vertical, with whatever planets are visible also in that plane. You should be able to FEEL this direction as being right, and it is an amazing feeling once you get it. Keep encouraging the kids to find ways to really FEEL this

direction — to feel like they are planet Earth spinning away from the Sun and while they are slowly circling the Sun in their orbit.]

[FYI: The plane of the solar system will not be exactly vertical above you unless you are in the tropics. It will be more vertical for you near Summer Solstice, and least at Winter Solstice.]

***Gather the kids back for discussion and orient the CD disk to the plane of the solar system, using your other arm to sweep the broad arc of the solar plane in the sky.***



Here is a photo of the **moon** just after sunset. The 3 bright dots to the right of it are 3 planets that happened to be in "conjunction" in their orbits when the photo was taken.

The topmost bright dot is **Mercury**.

The middle bright dot is **Jupiter**.

The bottom bright dot is **Mars**.

Seeing the planets at sunset (or sunrise) near the horizon is a great way to see and feel how **all the 8 planets orbit in an arc** that seems to be placed in the sky vertically on edge at sunset and sunrise.

**Q: "Point to where you think the sun will rise . . . Now pretend it is SUNRISE and face that spot on the eastern horizon. . . . Do you think Earth would be rotating away from or toward the sun at SUNRISE?"**

Photo left is at:

<http://apod.nasa.gov/apod/ap090226.html>

### **ENDING ACTIVITY:**

Ask the children to watch for when they can see the **first stars/planets** after sunset, and to call out when they see a new one just becoming bright enough to notice. Do this for at least 10 minutes if possible. As soon as you can see the first Red Giant, also do “**Breathing with Red Giants**” activity, while you keep watching for new stars to pop into view as it gets darker. Maybe also sing “**Twinkle Twinkle**” old and new verses just before you go indoors.

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NOTE: If you have online access inside, you might want to show a video of the Earth and Moon actually moving, as taken by a spacecraft in outer space. Go to:

[http://epoxi.umd.edu/4gallery/Earth-Moon\\_vid.shtml](http://epoxi.umd.edu/4gallery/Earth-Moon_vid.shtml)

## **NEW Outdoor ACTIVITY for AFTER DARK**

### **What did our human ancestors believe?**

Note: This activity must be done OUTDOORS when it is dark enough to see a lot of stars, identify a few constellations, and especially when you can see at least one planet. *If no planet is visible*, this activity makes no sense to do.

**Materials:** none.

**SUGGESTED DIALOGUE** (while outdoors looking at the night sky):

**Q: "If we were to come out again tonight at midnight, and also to look at the night sky once more just before dawn, would we see these stars in the SAME places?"** [Let them discuss; **don't answer yet!**]

**Point to a bright star (but not a planet!) as near to the WESTERN horizon as possible and that is easy to describe how to find. Ask your SkyWatch expert its name. [They may need to consult a Skymap they will have with them to find out.] After the kids all locate that particular star, ask:**

**Q: "If we were to come out here again in an hour, do you think we could still see that bright star? . . . Why or why not?"** [Let them discuss. Don't tell them the answer.]

• **"I'm not going to tell you the answer, because I think we can all do an EXPERIMENT together to find out."**

**Q: "Does anybody have a suggestion for an EXPERIMENT that would help us find out?"** [Surely some child will say something like, "Let's come back out later tonight and SEE if it has moved."]

• **"Okay, let's end our Skywatch for now and come back out here in about an hour or so and see if the stars have moved."**

• **"Before we go in, let's have everybody stand quietly and look at that particular star. . . . Notice how close it is to the horizon. . . . Notice the other stars around it . . . Now try to memorize what that part of the sky looks like, so that when we come back out here every single one of us can see for ourselves whether the stars move."**

**This CONCLUDES THE FIRST PART of this activity. Resume the Skywatch in an hour or more and continue the dialogue:**

**Return to the same spot with the kids and listen to them all exclaiming what they see before you start any dialogue again. Let them lead the program.**

- **"So. It does LOOK like the stars have moved."**

**Q: "Are the stars ACTUALLY moving in the sky?"** [Let them discuss; they should converge on the answer that the stars are just like the Sun. They seem to be moving only because the Earth is spinning on its axis. And so they seem to "set" in the West just like the Sun sets.]

- **"So the stars will all seem to move across the sky tonight, and they will "set" in the West, just like the Sun seems to set in the West."**

**Skip to the next red marker if the North Star cannot be seen. Continue reading if you can see the North Star.**

**Q: "But there is something really INTERESTING that happens to stars in the northern part of the night sky. Does anybody know what is so interesting about the stars in the northern part of the sky?"** [Let them discuss; usually nobody knows the correct answer.]

**Q: "Here is a clue: The answer has something to do with a particular star that is called THE NORTH STAR. . . . Can anybody locate the North Star?"** [Usually, nobody can.]

- **"Let's have our SKYWATCH helper show us where the North Star is and tell us how to find it so that whenever you are looking at the stars during the rest of your life you will always be able to find it on your own."**

[Wait for your Skywatch expert to do this. Make sure you or they

- (1) explain how to find the North Star, by navigating from the cup of the **Big Dipper**.
- (2) say that the official name of the North Star is **Polaris**.
- (3) explain **how and why Polaris never sets**.

- **"Let's all PRETEND again that we are Earth spinning on its axis. . . . So bend at the waist, with your head pointed north, and begin to spin again. . . ."**

**Q: "Can you FEEL why it is that Polaris never sets?"** [Let them discuss.]

**Q: "What about if we lived in the Southern Hemisphere? What if we lived in Antarctica? Would we see Polaris set?"** [Let them discuss. The answer is: We couldn't even see Polaris; we would see different stars. Maybe **use the Earth ball** and spin it pointed north, then put a mark on Antarctica and spin it again and ask the same question.]

**FYI: Here begins the dialogue about what our ancestors believed.**

**Q: "If nobody had ever told you that the Sun and stars really don't set but that it is Earth that is spinning instead, do you think you could have FIGURED that out on your own?"** [Let them discuss.]

**Q: "Do you think EVERYBODY IN YOUR FAMILY knows that the Sun and Stars aren't actually moving?"** [Let them discuss.]

**Q: "Do you think any human being living on Planet Earth 1,000 years ago knew that Earth was moving instead of the Sun and stars moving?"** [Let them discuss.]

● **"Actually, until about 500 years ago, even SCIENTISTS thought that the Sun and stars were moving and that Earth was stationary, never moving! It was COPERNICUS and GALILEO who first figured out that Earth was spinning on its axis and orbiting the Sun. Today, ALL SCIENTISTS know this fact."**

**Q: "Do you think anybody alive on Planet Earth TODAY who is not a scientist still thinks that the Sun and stars revolve around us?"** [Let them discuss.]

**Q: "What do you think it FELT like when YOUR ANCESTORS first had to accept that the Earth was no longer in the CENTER of the Universe? Do you think they would have been SCARED to think that they lived in a Universe in which Earth was moving — instead of the Sun and Stars moving?"** [Let them discuss.]

● **"Here is something fun to think about: Did you know that the word "PLANET" was invented long ago by people in Greece, who used that word to mean "wandering star". The word Planet actually means "wandering star" in the Greek language."**

**Q: "Can anybody figure out why the Greeks thought that a planet, like Venus and Mars and Jupiter and Saturn, was a wandering star?"**



**What does 'wandering' mean?"** [Let them discuss.]

- **"So even though the real stars do move across the sky every night, they always have the same position relative to one another. The constellations never change shape. But the planets actually do change their position in the sky from one month to the next, because they are orbiting the Sun and because we are orbiting the Sun too."**
- **"For example, this evening we can see Planet \_\_\_\_\_."**

**Show where the planet/s is.**

**Q: "Is a planet bright because it is squeezing atoms, like stars squeeze atoms and make energy?"** [no]

**Q: "If a planet is not creating heat and light, like a star creates its own heat and light by squeezing atoms, then WHAT MAKES A PLANET SO BRIGHT?"** [Let them discuss.]

- **"A planet in our Solar System is bright for 2 REASONS."**
- **"First, a planet that looks bright in the night sky is REFLECTING the light of the sun. We are looking at the DAYLIGHT side of the planet, and so it is reflecting the Sun back in our direction."**
- **"The second reason that a planet looks bright to us is because it is NEAR enough to Earth for us to see it without a telescope. We cannot see URANUS and NEPTUNE in the night sky because they are too far away. And, of course, we could never see any planets orbiting any other star besides our own star, the Sun."**
- **"So we can see Planet \_\_\_\_\_ tonight. And we will be able to see it for the next month or more. But there will be months ahead when we won't be able to see that planet. Instead, we will be able to see \_\_\_\_\_."** [FYI: There are only 4 planets we can easily see: Venus, Mars, Jupiter, and Saturn. We always see all of them in a year. So in the last part of the sentence name whatever planets you do not see tonight but will surely see later in the year.]
- **"A thousand years ago, the Greek people identified 2 main kinds of STARS: One kind is what they called "WANDERING STARS," which we now know are not really stars but planets, even though they still look like bright stars. All of the rest of the bright spots in the sky the Greek people called "FIXED STARS".**

**Q: "Why would anybody have called the real stars 'FIXED stars'? What does 'fixed' mean?"** [Let them discuss; 'fixed' means 'staying in the same spot.']

- **"So Venus and Mars and Jupiter and Saturn were called WANDERING stars. They were called "planets" because those bright spots in the night sky were always slowly changing their positions relative to the other bright spots. Meanwhile, year in and year out, all the rest of the bright spots stayed in exactly the same position relative to one another. The stars in the Big Dipper always stayed in the Big Dipper. So these unchanging bright spots were called the FIXED stars."**

- **"After COPERNICUS and GALILEO figured out that the Sun and the stars are not moving, but that Earth is spinning on its axis, they began to realize that Earth was a "Wandering Star" too! Earth was a Planet – just like Venus and Mars and Jupiter and Saturn."**

- **"Copernicus and Galileo realized that Earth was not just spinning on its axis, but that it was also orbiting the Sun."**

- **"Now here is something FUN to think about: If there were an ALIEN life form on MARS who liked to Skywatch at night, that alien would see Earth shining in their own night sky just like all the rest of the bright planets."**

**Q: "What color do you think Earth would look like to an alien who is watching the sky from Mars?"** [blue]

- **"From Mars, Earth would look like a BRIGHT BLUE DOT, because our planet is mostly blue OCEAN with a lot of white CLOUDS spread over the surface. So it would be a light blue color—like blue and white mixed together."**

- **"Let's PRETEND we are Martians right now. We are Martians who are looking up at the night sky from the surface of Mars. . . Let's pretend that we can see Earth shining way up there. It would look like a BRIGHT BLUE DOT. . . ."**

**Q: "Do you think Earth would look BEAUTIFUL?"**

**Q: "Do you think they would wonder whether there were any life forms on Earth?"**

**Q: "Do you think they would watch the sun set in their own western**

horizon and believe that the Sun really was actually moving? Or do you think they would have figured out, like we have, that their own planet is actually spinning on its axis and orbiting the Sun?"

**You can end the dialogue now.**

**If you have a battery-powered boombox, you can conclude by playing a SONG: "Blue Boat Home", written and sung by Peter Mayer. You can order a copy of the CD from:**

<http://thegreatstory.org/order-mayer.html>

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## DIALOGUE ABOUT THE MOON

FYI: If the MOON is visible, you can have this little dialogue:

**Q: "What stage is the MOON in right now?"** [half, quarter, crescent]

**Q: "Do you think that tomorrow night the MOON will be a little bit bigger or a little bit smaller?"** [Let them discuss.]

- **"Now here is something FUN to remember: If the MOON is visible in the sky WHILE THE SUN IS SETTING — or if you can see it faintly even during the DAYLIGHT hours before the sun sets — then you know that the MOON must be GETTING LARGER EACH DAY."**

- **"If you CANNOT see the MOON at SUNSET — and so you won't see it faintly in the sky during the daytime either — then you know that the Moon is getting SMALLER each day."**

**Q: "So, given what we saw of the night sky at sunset, will the Moon be bigger or smaller tomorrow night?"** [FYI: Even if you can't see the moon, technically either it is growing (waxing) or diminishing (waning) during every day of every monthly cycle.]

- **"Now, we know that the Moon is not ACTUALLY getting bigger or smaller. Rather, more of the SIDE of the Moon that is FACING EARTH is being lit by the Sun, or less of the side facing Earth is being lit by the sun."**

- **"It is too difficult to explain why all this is so, but if any of you are up to the task, see if you can FIGURE it out, or if you can go on the internet and find out why this is so and then try to explain it to all of**

us next time.”

- “But I have one more question that you may know the answer to:”

**Q: The moon cycles between being invisible and being full and bright. How long does it take for the moon to go from being full to being invisible and back to being full again?”** [28 days, about a month]

**Q: “Who among you has ever seen a full moon sometime during your life?”**

**Q: “How many FULL MOONS are there in a year?”** [12 or 13]

**Q: “Who wants to volunteer to go on the internet and find out when the next full moon when be – and who will then tell us the answer when we next meet?”** [Let any who wish volunteer to find the answer.]

END

### **ACTIVITY: “Pluto’s Identity Crisis” Parable**

When you return indoors, you can recruit volunteers to read the DRAMATIC SCRIPTS for the Pluto parable, which talks about the plane of the solar system, and how Pluto orbits at a slant to that plane, making it different from all the other planets.

The Pluto Parable can be downloaded in PDF at:

<http://thegreatstory.org/Pluto.html>