ScienceNews

IN HIGH SCHOOLS | EDUCATOR GUIDE

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October 14, 2017

SN 10: Scientists to Watch

SOCIETY FOR SCIENCE & THE PUBLIC

SN EDUCATOR GUIDE

October 14, 2017

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About the Issue

***Science News* article(s):** “Photosynthesis reinvented” and “How plants hunt water”

“Photosynthesis reinvented” Readability score: 12.4

“How plants hunt water” Readability score: 10.2

***Science News for Students* article(s):** “Cool Job: Rethinking how plants hunt for water”

Readability score: 7.1

This special issue features 10 early- and mid-career scientists who are on their way to widespread acclaim — they have already impacted their research fields, and in many cases, their careers are just getting started. Two of the SN 10: Scientists to Watch are Chong Liu and José Dinneny. The article “Photosynthesis reinvented” describes how Liu is developing a highly efficient artificial photosynthetic system driven by bacteria-friendly catalysts. “How plants hunt water” describes Dinneny’s investigation of how lateral roots are able to grow toward water. Students can focus on details reported in the articles, follow connections to earlier articles about photosynthesis and plants and explore cross-curricular connections to other major science topics in biology, chemistry, physics and engineering. In a related activity, students will explore the remaining SN 10 scientists and develop their own Jeopardy!-like game. After playing the game, students can analyze common character traits of the scientists, brainstorm potential career options in the science, technology, engineering and mathematics (STEM) fields, and think more in-depth about the research conducted by early- and mid-career scientists.

SN EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Article-based observation: Questions focus on the research performed by two of the SN 10 scientists, Chong Liu and José Dinneny. The topics relate to how scientists are developing artificial photosynthesis and studying how plant roots seek water.

Quest through the archives: Use this short section to explore other articles about photosynthesis and plants as reported by *Science News* since 1924.

Cross-curricular discussion:

Biological Sciences questions focus on chloroplasts and light and dark reactions in photosynthesis.

Chemical Sciences questions address light absorption, electrolysis and the molecular structure and function of chlorophyll.

Physical Sciences questions concern photon energies and photovoltaics.

Engineering and Experimental Design questions deal with various applications for the technologies from the two articles.

Activity: Who are the SN 10 Scientists?

Purpose: To gain a better understanding of the character traits, personal qualities, career paths, STEM-related fields and the science behind the SN 10 scientists' research.

Procedural overview: Students work in groups of two or three to come up with Jeopardy!-like answers and questions about the 10 young scientists covered in this issue. Once answers are submitted, a game can be prepared for the next class.

Approximate class time: Two classes, or approximately 80 – 90 minutes total.

SN EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Standards

Next Generation Science	Common Core ELA
Energy: HS-PS3-1, HS-PS3-2	Reading Informational Text (RI): 1, 2, 4, 5, 7
From Molecules to Organisms: Structures and Processes: HS-LS-2, HS-LS1-4, HS-LS1-5, HS-LS1-7	Writing (W): 1, 2, 3, 4, 6, 7, 8, 9
Ecosystems: Interactions, Energy, and Dynamics: HS-LS2-4, HS-LS2-5, HS-LS2-7	Speaking and Listening (SL): 1, 2, 4, 5, 6
Earth and Human Activity: HS-ESS3-2, HS-ESS3-4	Reading for Literacy in Science and Technical Subjects (RST): 1, 2, 3, 4, 5, 7, 8, 9
Engineering Design: HS-ETS1-1, HS-ETS1-2, HS-ETS1-3	Writing Literacy in History/Social Studies and Science and Technical Subjects (WHST): 1, 2, 4, 7, 8, 9

SN EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Article-Based Observation: Q&A

Based on the article "Photosynthesis reinvented" about Chong Liu:

1. What personal characteristics and decisions helped make Chong Liu a successful scientist?

Possible student response: Chong Liu became a successful scientist, in part, by asking questions "beyond the scope of what he needed to know," looking for a challenging and important problem to solve, trying new solutions to previously discovered problems and operating at the less-explored boundary between chemistry and microbiology.

2. What inspired Chong Liu to become a scientist?

Possible student response: Learning chemistry in high school and wanting to go beyond what he was being taught as an undergraduate inspired Liu to become a scientist. He liked research because it allowed him to find the answers to his own questions.

3. What was the objective of Chong Liu's research that was reported in *Science* in 2016? What is the objective of the research he is currently conducting in his lab at UCLA?

Possible student response: By developing new catalysts, Liu created an artificial photosynthetic system that is more efficient than some natural or previous artificial photosynthetic systems. Ultimately, this system could be used to turn energy from the sun into fuel while also removing carbon dioxide from air. At the University of California, Los Angeles, Liu is currently trying to determine the symbiotic relationship between microbes and soil. Eventually, Liu would like to mimic microbes' chemical reactions that occur in soil.

4. What helped inspire and define Chong Liu's research topics?

Possible student response: Liu's artificial photosynthesis research was inspired by the chemical reactions leaves use to make food, as well as his knowledge of an attempt to build a life-support system for manned space missions in the late '60s and early '70s. Had the support system worked, it would have turned astronauts' exhaled carbon dioxide into food using specialized bacteria and inorganic materials.

5. How does this work differ from natural photosynthesis? Be as specific about the science involved as possible.

Possible student response: In natural photosynthesis, bacteria-like organelles, called chloroplasts, in plant cells absorb light energy and use that energy to split water into hydrogen and oxygen, and then combine the hydrogen with carbon dioxide to make high-energy molecules like sugar. In the artificial photosynthetic system, chemical catalysts use light energy absorbed by solar panels to split water into hydrogen and oxygen. Bacteria then combine the hydrogen with carbon dioxide from air to make high-energy molecules such as isopropanol.

6. What are some ways in which Chong Liu's research could be applied outside of the lab?

Possible student response: Liu and colleagues used the photosynthetic setup and different bacteria to turn nitrogen into ammonia for fertilizer. It could lead to a more sustainable approach to producing fertilizer, which is important for agriculture.

7. What overall STEM field(s) does this research belong to? What other types of STEM careers could utilize the STEM field(s) covered in the article?

Possible student response: The research covers fields in chemistry (for the catalysts) and microbiology (for the bacteria). Chemists can have careers creating molecules, ranging from drugs to clothing dyes, or measuring natural or artificial molecules. Microbiologists can have careers ranging from detecting and treating infections to genetically engineering useful microbes.

Based on the article "How plants hunt water" about José Dinneny:

1. What personal characteristics and decisions helped make José Dinneny a successful scientist?

Possible student response: Dinneny attributes his success as a scientist to hard work and his determination to be intellectually challenged in his classes. He was also recognized for operating at the boundary between molecular biology and agricultural plant biology, and for developing new tools to measure plant root growth.

2. What inspired José Dinneny to become a scientist?

Possible student response: Dinneny realized his own science talent during his Advanced Placement biology class. He was the only person in his class who knew the answer to a question about DNA. Once he gained confidence in his own science ability, Dinneny started pushing himself by taking more advanced classes.

3. What was the inspiration that helped define José Dinneny's research topic?

Possible student response: For much of his childhood, Dinneny enjoyed learning about the ocean and its "strange" deep-sea creatures. When Dinneny was older, he found that plants were just as "alien-like" as the deep-sea creatures. He was interested to know how plants seemingly made coherent decisions while growing without a nervous system or a brain.

4. What was José Dinneny's objective of his research?

Possible student response: His general objective was to study and explain how plant roots sense and grow toward water. More specifically, Dinneny wanted to determine how plants react on a cellular level to their environment.

5. What new method did he develop for his research?

Possible student response: Dinneny created two-dimensional root systems using plants genetically engineered to glow as different genes turned on. He took computer scans of the roots while they grew over the course of many days. They called the method GLO-Roots.

6. What overall STEM field(s) does this research belong to? What other types of STEM careers could utilize the STEM field(s) covered in the article?

Possible student response: The research covers molecular biology and botany. Molecular biologists can pursue a wide range of careers, from studying how certain genes and proteins work to genetically engineering entirely new genes. Botanists can pursue careers ranging from the basic science of how plants function to applied research to improve agricultural crops.

7. After reading both articles, how are these two scientists similar?

Possible student response: Both scientists have drawn inspiration from the molecular lives of plants. The scientists are also similar in that they are extremely self-motivated and are especially driven by new challenges.

EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Article-Based Observation: Q

Directions: Read the articles "Photosynthesis reinvented" and "How plants hunt water" and then answer these questions:

Based on the article "Photosynthesis reinvented" about Chong Liu:

1. What personal characteristics and decisions helped make Chong Liu a successful scientist?

2. What inspired Chong Liu to become a scientist?

3. What was the objective of Chong Liu's research that was reported in *Science* in 2016? What is the objective of the research he is currently conducting in his lab at UCLA?

4. What helped inspire and define Chong Liu's research topics?

5. What new method did he develop for his research?

6. What are some ways in which Chong Liu's research could be applied outside of the lab?

7. What overall STEM field(s) does this research belong to? What other types of STEM careers could utilize the STEM field(s) covered in the article?

Based on the article "How plants hunt water" about José Dinneny:

1. What personal characteristics and decisions helped make José Dinneny a successful scientist?

2. What inspired José Dinneny to become a scientist?

3. What was the inspiration that helped define José Dinneny's research topic?

4. What was José Dinneny's objective of his research?

5. What new method did he develop for his research?

6. What overall STEM field(s) does this research belong to? What other types of STEM careers could utilize the STEM field(s) covered in the article?

7. After reading both articles, how are these two scientists similar?

SN 10: Scientists to Watch

Quest Through the Archives: Q&A

1. The article about Chong Liu mentions that his research is related to the work of Daniel Nocera. Can you find an earlier article about Daniel Nocera's research?

Possible student response: The article "Hydrogen made using sunlight, cheap materials," published 9/16/2014, discusses the electrochemical methods Chong Liu later combined with bacteria in his research. As described in "Hydrogen made using sunlight, cheap materials," photovoltaic, or solar, cells can absorb energy from sunlight and convert it into electricity to power the chemical reaction of splitting water into hydrogen and oxygen using catalysts composed of Earth-abundant elements. When compared to natural biological photosynthesis, the efficiency of Nocera's system to split water molecules is approximately 10 times higher. There are several other articles about Nocera's research too; he has been slowly improving his catalysts and his system over the course of many years.

2. Can you find an article about how photosynthesis in plants can help absorb some of the excess carbon dioxide that is now in our atmosphere?

Possible student response: The article "CO_2-loving plants can counter human emissions," published 11/8/2016, discusses how plants can absorb a sizeable fraction of human-produced CO_2. Via photosynthesis, plants convert that CO_2 into larger carbon-containing molecules stored in the plants. The photosynthetic process in plants is more efficient when CO_2 is abundant. While rising CO_2 levels had accelerated from a yearly increase of 0.75 parts per million in 1959 to 1.86 parts per million by 1989, between 2002 and 2014 the rate remained relatively stable at around 1.9 parts per million.

3. The article about José Dinneny explained how plant roots can seek out water. Can you find an article that explains how plant roots can attract helpful bacteria and repel harmful bacteria?

Possible student response: The article "Defense hormones guide plant roots' mix of microbes," published 7/16/2015, discusses how plant roots produce hormones such as salicylic acid, jasmonic acid and ethylene. These hormones help to attract beneficial bacteria, such as the bacteria involved in nitrogen fixation, a process that converts atmospheric nitrogen into ammonia that plants can use. The hormones also repel harmful bacteria that might prefer to eat the plants or their roots. Plants that were genetically engineered not to produce the hormones had a different and less healthy mix of bacteria growing around their roots.

SN EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Quest Through the Archives: Q

Directions: After reading the articles "Photosynthesis reinvented" and "How plants hunt water," log in to your *Science News* in High Schools account and use the Search page to answer these questions. Make sure you adjust the filters to include articles written before 1999, if the question requires you to do so.

1. The article about Chong Liu mentions that his research is related to the work of Daniel Nocera. Can you find an earlier article about Daniel Nocera's research?

2. Can you find an article about how photosynthesis in plants can help absorb some of the excess carbon dioxide that is now in our atmosphere?

3. The article about José Dinneny explained how plant roots can seek out water. Can you find an article that explains how plant roots can attract helpful bacteria and repel harmful bacteria?

SN EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Cross-Curricular Discussion: Q&A

Directions: After students have had a chance to review the articles "Photosynthesis reinvented" and "How plants hunt water," lead a classroom discussion based on the questions that follow.

BIOLOGICAL SCIENCES

Discussion questions:

1. What are chloroplasts?

Chloroplasts are organelles within the cells of plants and green algae that convert light energy into chemical energy via photosynthesis. Inside a chloroplast are disk-shaped structures called thylakoids. Thylakoids contain light-absorbing chlorophyll molecules that allow the energy from sunlight to be converted and stored as chemical energy. Thylakoids are arranged into stacks (each stack is called a granum) and connected by bridges (called lamellae). Like the bacteria from which they descended, chloroplasts have a DNA nucleoid, ribosomes and storage granules for nutrients (starch).

Extension prompts:

2. What are the light reactions in chloroplasts and what do they make?

Light reactions are the parts of photosynthesis that can only happen while there is a light energy source. When exposed to light, thylakoid disks embedded in chloroplasts absorb photons of light. This light energy initiates the reaction that splits water (H_2O) into hydrogen (H_2) and oxygen (O_2), and ultimately generates adenosine triphosphate (ATP). ATP powers the cell's metabolic activity.

3. What are the dark reactions in chloroplasts and what do they make?

Dark reactions, also called light-independent reactions, are steps of photosynthesis that do not require photons to proceed. In a process called the Calvin cycle, dark reactions in thylakoids combine hydrogen (from the light reactions) with CO_2 to make the sugar building block glyceraldehyde 3-phosphate.

4. What are the dark reactions outside of chloroplasts in plant cells and what do they make?

Dark reactions that occur outside of chloroplasts in plant cells' cytosol convert glyceraldehyde 3-phosphate, a product of the Calvin cycle, into glucose and other saccharides.

CHEMICAL SCIENCES

You may want to explore the "Chemistry and Other Physical Sciences Discussion Q&A" in the Built for Speed Educator Guide if you are interested in additional questions about catalysts and activation energy.

Discussion questions:

1. How does an atom absorb light energy? What about molecules?

Based on an atom's structure, it can absorb photons of light at specific wavelengths. An electron within an atom absorbs the incident photon of light — as the electron absorbs the light energy it is promoted from its ground state energy level to a higher energy level called the excited state. The electron is not stable in the excited state, so it generally returns back to the ground state releasing the energy initially absorbed in the form of heat. Generally, the same process occurs when molecules absorb light. Once an electron in a molecule absorbs energy, the high-energy electron generally falls back down to the ground state, but if an electron acceptor is nearby, the excited electron can move to the acceptor. This electron transfer can initiate a series of other chemical reactions.

2. Write the chemical formula and draw the skeletal or shorthand chemical structure of chlorophyll a. Circle all the double bonds in your structure.

Chlorophyll a has the chemical formula of $C_{55}H_{72}MgN_4O_5$*. See the National Institutes of Health PubChem Open Chemistry Database for the [shorthand molecular structure of chlorophyll a](). *

Extension prompts:

3. What is chlorophyll a and how does its structure relate to its function?

Chlorophyll a is the molecule that initially absorbs light energy in photosynthesis. Chlorophyll a belongs to a family of biological molecules called porphyrins, which also includes heme (from hemoglobin). Like other porphyrins, chlorophyll a is a flower-shaped molecule with a metal ion at the center of the flower (magnesium for chlorophyll, iron for heme), and it has alternating single and double bonds around the rings that make up the "petals" of the flower. Alternating double and single bonds, or conjugated multiple bonds, allow electrons to move freely. Double bonds become single bonds and single bonds become double bonds, then back again. When these "free electrons" absorb red and blue light, they get promoted to higher energy levels that coincide with the amount of energy gained.

4. What is electrolysis and how can electrolysis of water be demonstrated?

Electrolysis, or electrical splitting of water into hydrogen and oxygen, can be accomplished by connecting two wires to electrodes of a six-volt or nine-volt battery and immersing the wires (not touching each other) in a glass of water. Adding some salt to the water increases the electrical conductivity and speeds up the process. Bubbles of oxygen gas form at the positive electrode and bubbles of hydrogen gas form at the negative electrode. If desired, the gases can be collected by placing inverted test tubes over the ends of the wires.

PHYSICAL SCIENCES

Discussion questions:

1. How much energy is in light? Explain and give specific examples for red and violet light.

Light is electromagnetic waves with velocity $c = 3x10^8$ *m/sec (approximately), frequency* f *and wavelength* λ*. Equivalently, light can be thought of as quantum particles called photons. The energy of each photon, and thus, the maximum energy imparted to a molecule or device that absorbs that photon, is* $E = hf = hc/\lambda$*, in* *which* $h \approx 4.14 \times 10^{-15}$ *eV sec is Planck's constant. (eV is an electron volt or the energy of one electron coming from a one-volt battery.) For red light with a wavelength* $\lambda = 7 \times 10^{-7}$ *m, each photon has an energy E = 1.77 eV. For violet light with a wavelength* $\lambda = 4 \times 10^{-7}$ *m, each photon has an energy E = 3.11 eV.*

2. Why does chlorophyll a appear green? What wavelength(s) of light does it absorb?

Chlorophyll a appears green because it reflects (does not absorb) wavelengths of green light. It absorbs wavelengths of light that correspond to the red (approximately 650 nm to 700 nm) and blue/violet regions (approximately 400 nm to 450 nm). See the Chlorophyll Absorption Spectrum on University of Illinois chemist Patricia Shapley's website.

Extension prompts:

3. How do photovoltaic panels (solar cells) work?

Photovoltaic panels use semiconductors (usually silicon) that convert light energy to electrical energy. When an atom in the semiconductor absorbs a photon, the energy from that photon knocks an electron out of a tight (valence) orbit around the atom. This frees it to roam around as a conduction electron with an overall negative charge. The atom that is now missing one electron has a net positive charge. That absence of an electron can be thought of as a positively charged "hole" that can wander from atom to atom, as one atom steals a replacement electron from a neighboring atom. In an electric field, negatively charged electrons go one way and positively charged holes go the other way. If the photovoltaic panel is connected via wires to a circuit, charges can flow out of the panel into the circuit, do useful work and then the electrons and holes can be reunited in the panel.

ENGINEERING AND EXPERIMENTAL DESIGN

Discussion questions:

1. What are some possible extensions and applications that you can think of for Chong Liu's technology?

Chong Liu's technology could allow scientists to convert sunlight to sugar or other food ingredients more efficiently, convert sunlight to fuel more efficiently, convert sunlight to electricity more efficiently, remove CO_2 *from earth's atmosphere, recycle air in a spacecraft or spacesuit, recycle air in a submarine or diving suit and produce ammonia and isopropanol in more energy-efficient ways.*

2. What are some possible extensions and applications that you can think of for José Dinneny's technology?

José Dinneny's technology could allow scientists to genetically engineer plants that glow various colors in response to various conditions. This ability could indicate the health of agricultural crops or houseplants. Scientists could also use these genetically engineered glowing plants as sensors in the environment to warn of air pollution, toxins in the soil or water, landmines or other explosives. Using the GLO-Roots system could also allow scientists to engineer plants to respond to environmental conditions so that they can better survive heat, cold, droughts or pests.

Extension prompts:

3. What would inspire more students to become scientists? What has inspired you to pursue an academic endeavor in your life?

Student answers will vary.

SN EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Cross-Curricular Discussion: Q

Directions: The following list of discussion questions is provided to help you take notes, brainstorm ideas and test your thinking in order to be more actively engaged in class discussions related to this article. All questions in this section are related to topics covered in "Photosynthesis reinvented" and "How plants hunt water."

BIOLOGICAL SCIENCES

Discussion questions:

1. What are chloroplasts?

Extension prompts:

2. What are the light reactions in chloroplasts and what do they make?

3. What are the dark reactions in chloroplasts and what do they make?

4. What are the dark reactions outside of chloroplasts in plant cells and what do they make?

CHEMICAL SCIENCES

You may want to explore the "Chemistry and Other Physical Sciences Discussion Q" in the Built for Speed Educator Guide if you are interested in additional questions about catalysts and activation energy.

Discussion questions:

1. How does an atom absorb light energy? What about molecules?

2. Why does chlorophyll a appear green? What wavelength(s) of light does it absorb?

Extension prompts:

3. What is chlorophyll a and how does its structure relate to its function?

4. What is electrolysis and how can electrolysis of water be demonstrated?

PHYSICAL SCIENCES

Discussion questions:

1. How much energy is in light? Explain and give specific examples for red and violet light.

2. Why does chlorophyll a appear green? What wavelength(s) of light does it absorb?

Extension prompts:

3. How do photovoltaic panels (solar cells) work?

ENGINEERING AND EXPERIMENTAL DESIGN

Discussion questions:

1. What are some possible extensions and applications that you can think of for Chong Liu's technology?

2. What are some possible extensions and applications that you can think of for José Dinneny's technology?

Extension prompts:

3. What would inspire more students to become scientists? What has inspired you to pursue an academic endeavor in your life?

SN EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Activity Guide for Teachers: Who are the SN 10 Scientists?

Purpose: To gain a better understanding of the character traits, personal qualities, career paths, STEM-related research fields and the science behind the SN 10 scientists' research.

Procedural overview: Students work in groups of two or three to come up with Jeopardy!-like answers and questions about the 10 young scientists covered in this issue. Once answers are submitted, a game can be prepared for the next class.

Approximate class time: Two classes, or approximately 80 – 90 minutes total.

Materials:

- Activity Guide for Students: Who are the SN 10 Scientists?
- *Science News* articles on 10 young scientists

Notes to the teacher: Students should work in groups of two or three. Each group is assigned a different scientist from the 10 scientists profiled in this issue of *Science News*. Students in each group should come up with Jeopardy!-style answers and questions for their assigned scientist, based on information in the *Science News* article. (Similar content was covered with the article-based observation section in this guide.) Students should come up with one answer and its corresponding question for each of these six categories:

1. Personal Characteristics: personal traits that helped to make this scientist successful

2. Inspiration to be a Scientist: things that inspired this person to become a scientist

3. Research Objectives: the objectives of this scientist's research

4. Details of Research: a detailed question about this scientist's research

5. STEM Fields: the STEM field(s) related to this scientist's research or general questions about the fields

6. Related Careers: other types of STEM careers that one could pursue in the STEM field(s) covered in the article.

Students can spend up to one class period (or approximately 40-45 minutes) working in groups to write their answers and questions, and then they can submit them to the teacher. The teacher can assemble those answers and questions into a Jeopardy!-style board under the six categories listed above. Easier pairs of answers/questions can be assigned lower point values, and harder pairs can be assigned higher point values:

- 200 Klingon darseks
- 400 Klingon darseks
- 600 Klingon darseks

- 800 Klingon darseks
- 1000 Klingon darseks

Before the next class, the homework for the teacher is to assemble the students' answers and questions into a Jeopardy!-style board:

Personal Characteristics	Inspiration to be a Scientist	Research Objectives	Details of Research	STEM Fields	Related Careers
200	200	200	200	200	200
400	400	400	400	400	400
600	600	600	600	600	600
800	800	800	800	800	800
1000	1000	1000	1000	1000	1000

Note that you only need 6 x 5= 30 pairs of answers and questions for the game, whereas students will have submitted up to 6 x 10 = 60 pairs, so the teacher can choose only the better pairs to include in the game. However, the pairs chosen should cover the scientists and the student teams in a fair and representative fashion. The students' sheets are designed to be cut apart by the teacher in preparation for the game. Students are not allowed to answer a question that their team submitted, which is why it is important for the students to write their names on every answer/question pair that they submit. You might want to start off the class with your favorite Jeopardy! clip, or at least the theme song! Also, feel free to create the final category and question for the game, so student groups can wager their points.

Before the next class, the students' homework is to read the articles about all of the scientists and take notes.

After the game, the teacher can wrap up the activity by asking the class some unifying questions, such as:

1. What personal characteristics are shared by many or all of the scientists? Why might that be?

2. What are some common sources of inspiration to become a scientist? For students in the class who would like to go into STEM careers, what has inspired them? What has inspired students to want to pursue careers outside of STEM?

3. How do (or should) scientists choose their research objectives?

4. What are the various methods that scientists use to solve different problems?

5. How many different STEM fields are represented by these scientists? What important STEM fields are not included in this small sample of scientists?

6. What have you learned about scientific careers from these articles and this activity?

EDUCATOR GUIDE

October 14, 2017

SN 10: Scientists to Watch

Activity Guide for Students: Who are the SN 10 Scientists?

Purpose: To gain a better understanding of the character traits, personal qualities, career paths, STEM-related research fields and the science behind the SN 10 scientists' research.

Procedural overview: Students work in groups of two or three to come up with Jeopardy!-like answers and questions about the 10 young scientists covered in this issue. Once answers are submitted, a game can be prepared for the next class.

Instructions: Each group is assigned a different scientist from the 10 scientists profiled in this issue of *Science News*. After reading the article and taking notes, work with your group to come up with Jeopardy!-style answers and questions for your assigned scientist, based on information in the *Science News* article. Don't forget to word your Jeopardy!-style clues as answers, so that the audience will answer the clues with a question. Groups should come up with one answer and its corresponding question for each of six categories. Your teacher will cut this handout apart and mix your answer/question pairs with those of other groups. When playing the game, you will not be allowed to answer a question that your group submitted, so it is important to write the names of your group members on each answer/question pair:

1. Personal Characteristics: personal traits that helped to make this scientist successful

Jeopardy!-style answer:

Jeopardy!-style question:

Names of your group members:

2. Inspiration to be a Scientist: things that inspired this person to become a scientist

Jeopardy!-style answer:

Jeopardy!-style question:

Names of your group members:

3. Research Objectives: the objectives of this scientist’s research

Jeopardy!-style answer:

Jeopardy!-style question:

Names of your group members:

4. Details of Research: a detailed question about this scientist’s research

Jeopardy!-style answer:

Jeopardy!-style question:

Names of your group members:

5. STEM Fields: the STEM field(s) related to this scientist’s research or general questions about the fields

Jeopardy!-style answer:

Jeopardy!-style question:

Names of your group members:

6. Related Careers: other types of STEM careers that one could pursue in the STEM field(s) covered in the article

Jeopardy!-style answer:

Jeopardy!-style question:

Names of your group members:

After the game is over, spend time answering the following questions:

1. What personal characteristics are shared by many or all of the scientists? Why might that be?

2. What are some common sources of inspiration to become a scientist? For students in the class who would like to go into STEM careers, what has inspired you? If you want to pursue careers outside of STEM, what has inspired you?

3. How do (or should) scientists choose their research objectives?

4. What are the various methods that scientists use to solve different problems?

5. How many different STEM fields are represented by these scientists? What important STEM fields are not included in this small sample of scientists?

6. What have you learned about scientific careers from these articles and this activity?

October 14, 2017

SN 10: Scientists to Watch

Other Related Articles

Science News for Students: "Catching some rays"
Readability score: 8.8

Science News for Students: "Cool Jobs: Like Mother Nature"
Readability score: 7.8

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