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Photosynthesis and Cellular Respiration (LS1): A Hands-On Approach Supporting the NGSS and ELA CCSS

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Photosynthesis and Cellular Respiration (LS1): A Hands-On Approach Supporting the NGSS and ELA CCSS

Photosynthesis and Cellular Respiration (LS1): A Hands-On Approach for Grades 6-12

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EAST TENNESSEE STATE
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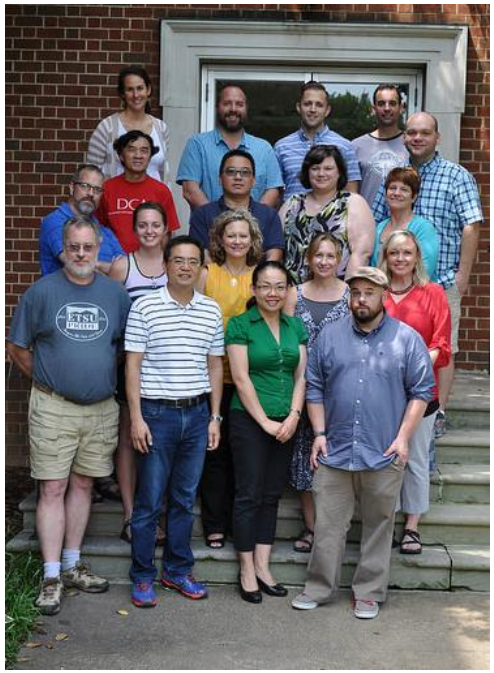
Preparing College/Career Readiness through Integrating Science Learning with Literacy in Grades 6-12

A LEA-ETSU-Business Partnership Initiative Supported by TN DOE MSP and THEC ITQ Grants (2015-17)



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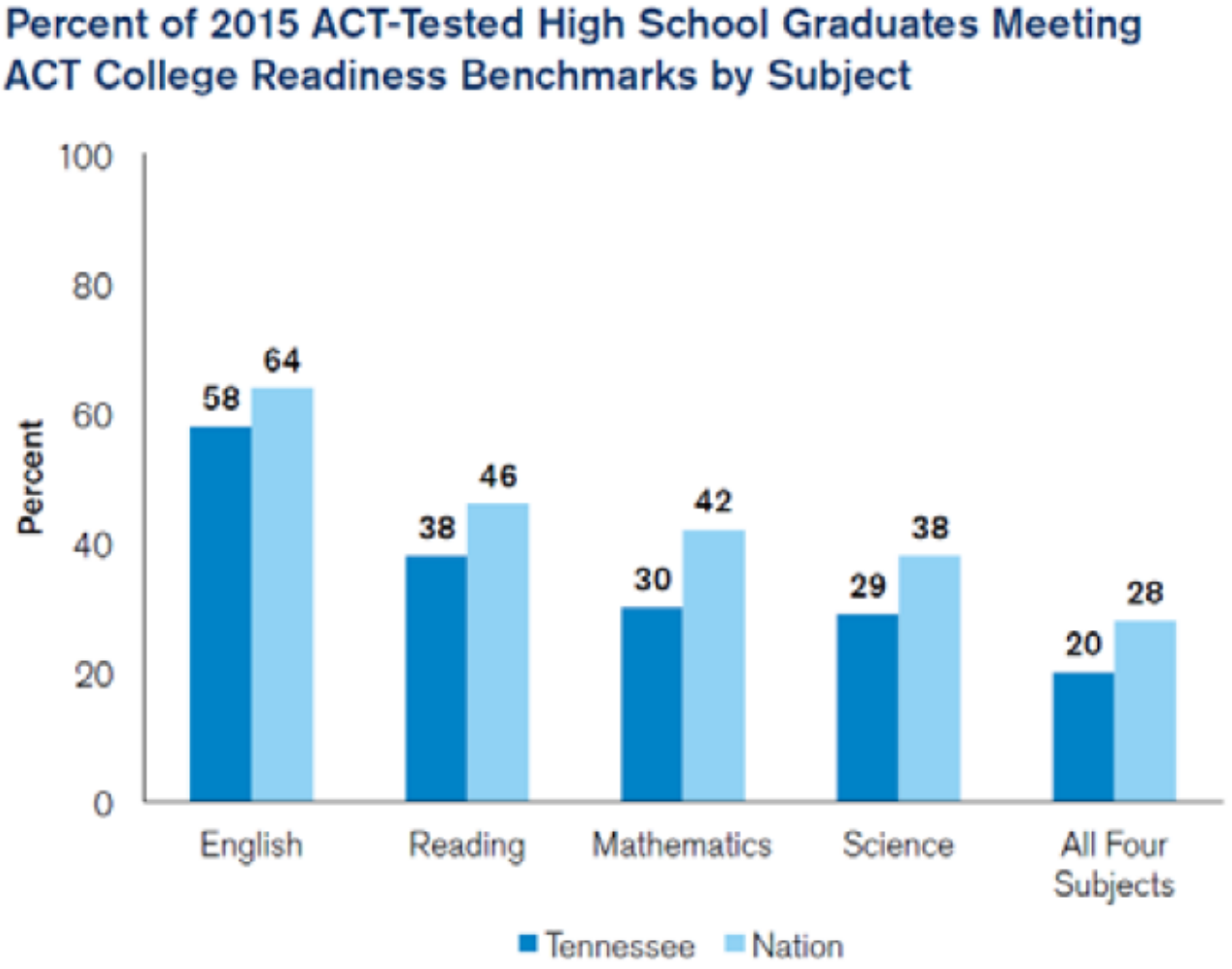
Picture of College Readiness

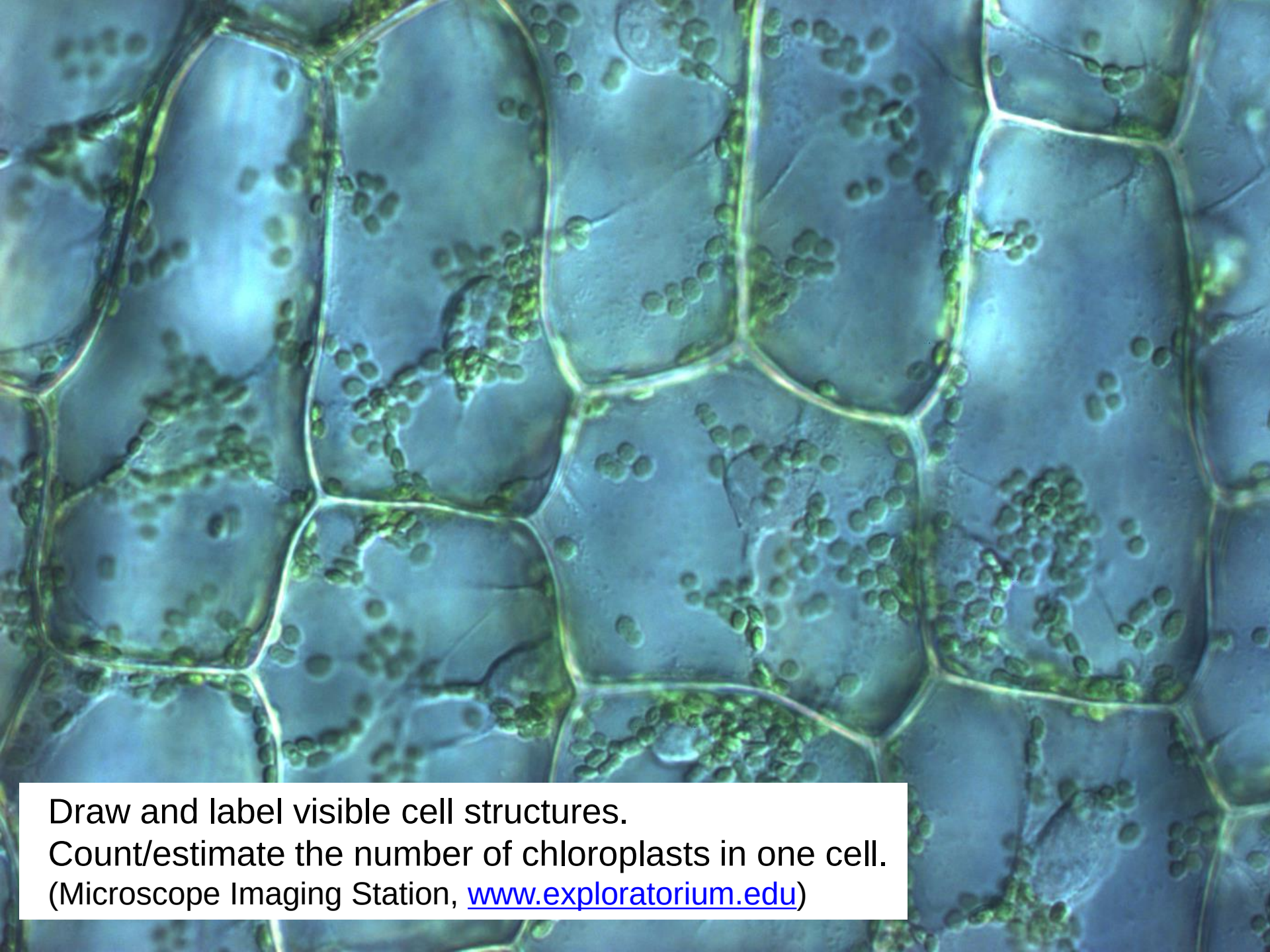


Research Questions

- **RQ1**: How does cross-discipline instruction benefit and enrich each subject discipline?
- **RQ2**: How does integration of science learning with literacy in G6-12 impact college/career readiness?

Elodea Observation

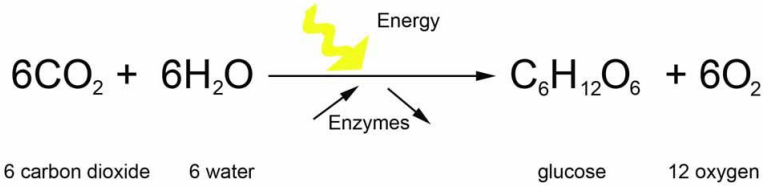
- Qualitative observations:
  - What colors and shades are present?
  - Describe the shapes of the leaves and stems.
  - How are the leaves arranged on the stem?
  - What textures do you observe?
- Quantitative observations:
  - What is the size of a typical leaf? Thickness of the stem? Number of visible veins?
  - How many leaves and stems are on your sample?



Draw and label visible cell structures.
Count/estimate the number of chloroplasts in one cell.
(Microscope Imaging Station, www.exploratorium.edu)

Big Ideas & Common Misconceptions

- Starting ingredients (CO_2 & H_2O) are rearranged to form new substances (glucose & O_2).
- Light energy from the sun is trapped in the chemical bonds of glucose for later use by plants.
- The reactants become the products.
- Plants do not perform photosynthesis as a public service to consumers.
- Plants carry out cellular respiration too.



Middle Grades
NGSS & Common Core Integration

NGSS	Common Core
MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	**RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-6) **RST.6-8.2** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-6) **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-6)
MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.	**WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-6) **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-7)

A Special Note about Vocabulary

1st – hands-on

2nd - introduce formal vocabulary

- Share with ELA partners that hands-on is needed first.
- Hands-on becomes a scaffold on which to hook new vocabulary.

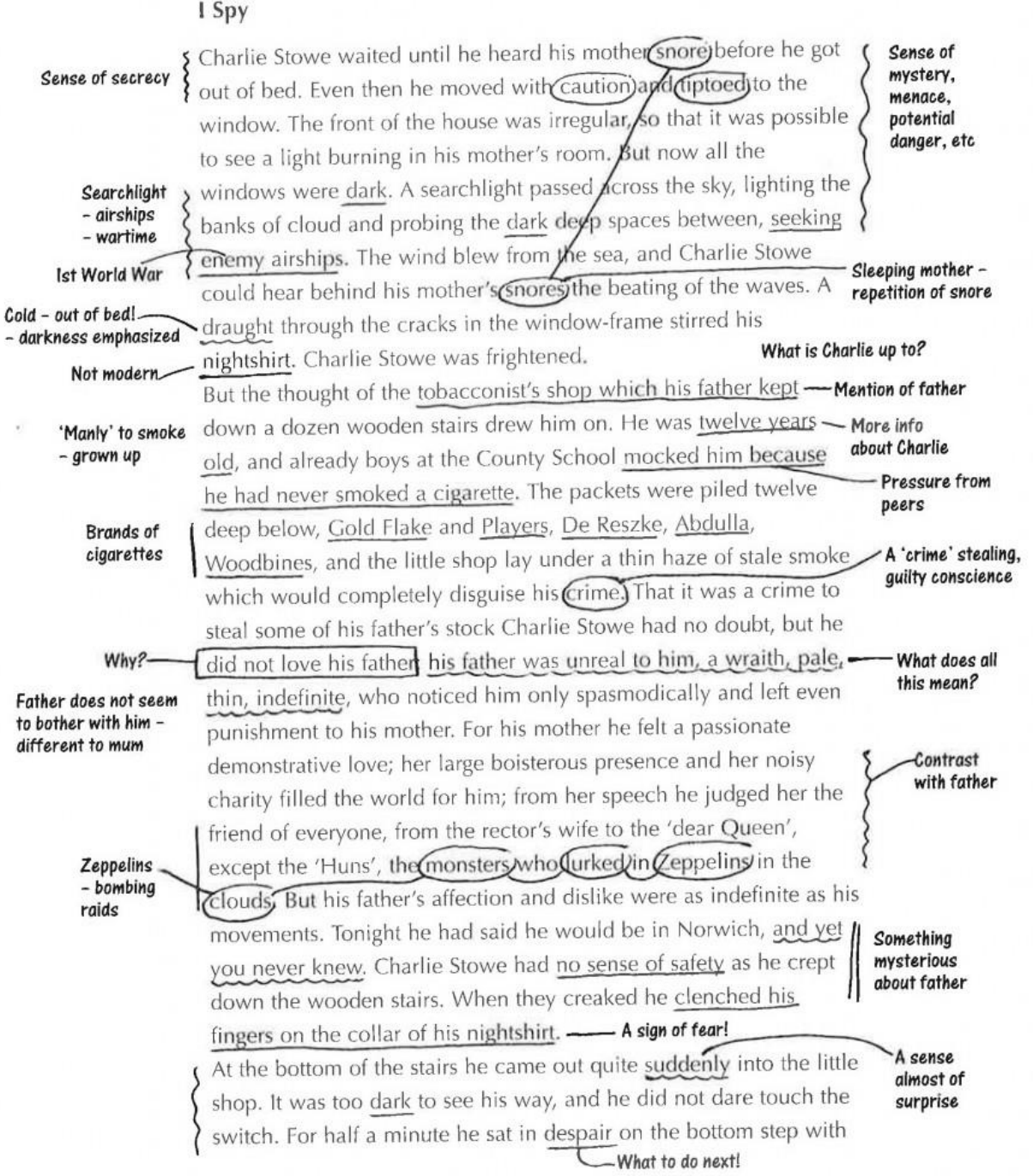
Annotations in Grades 3-5

- *Underline* the major points.
- *Circle keywords or phrases* that are confusing or unknown to you.
- *Use a question mark (?)* for questions that you have during the reading. Be sure to write your question.

Annotation in Grades 6-8

- *Underline* the major points.
- *Circle keywords or phrases* that are confusing or unknown to you.
- *Use a question mark (?)* for questions that you have during the reading. Be sure to write your question.
- ***Use an exclamation mark (!)* for things that surprise you, and briefly note what it was that caught your attention.**
- ***Draw an arrow (↲) when you make a connection to something inside the text, or to an idea or experience outside the text. Briefly note your connections.**

Modeled annotation in Seventh Grade



I Spy

Charlie Stowe waited until he heard his mother snore before he got out of bed. Even then he moved with caution and tiptoed to the window. The front of the house was irregular, so that it was possible to see a light burning in his mother's room. But now all the windows were dark. A searchlight passed across the sky, lighting the banks of cloud and probing the dark deep spaces between, seeking enemy airships. The wind blew from the sea, and Charlie Stowe could hear behind his mother's snores the beating of the waves. A draught through the cracks in the window-frame stirred his nightshirt. Charlie Stowe was frightened.

But the thought of the tobacconist's shop which his father kept down a dozen wooden stairs drew him on. He was twelve years old, and already boys at the County School mocked him because he had never smoked a cigarette. The packets were piled twelve deep below, Gold Flake and Players, De Reszke, Abdulla, Woodbines, and the little shop lay under a thin haze of stale smoke which would completely disguise his crime. That it was a crime to steal some of his father's stock Charlie Stowe had no doubt, but he did not love his father his father was unreal to him, a wraith, pale, thin, indefinite, who noticed him only spasmodically and left even punishment to his mother. For his mother he felt a passionate demonstrative love; her large boisterous presence and her noisy charity filled the world for him; from her speech he judged her the friend of everyone, from the rector's wife to the 'dear Queen', except the 'Huns', the monsters who lurked in Zeppelins in the clouds. But his father's affection and dislike were as indefinite as his movements. Tonight he had said he would be in Norwich, and yet you never knew. Charlie Stowe had no sense of safety as he crept down the wooden stairs. When they creaked he clenched his fingers on the collar of his nightshirt.

At the bottom of the stairs he came out quite suddenly into the little shop. It was too dark to see his way, and he did not dare touch the switch. For half a minute he sat in despair on the bottom step with

Sense of secrecy

Sense of mystery, menace, potential danger, etc

Searchlight – airships – wartime

1st World War

Sleeping mother – repetition of snore

Cold – out of bed! – darkness emphasized

What is Charlie up to?

Not modern

Mention of father

'Manly' to smoke – grown up

More info about Charlie

Pressure from peers

Brands of cigarettes

A 'crime' stealing, guilty conscience

Why?

What does all this mean?

Father does not seem to bother with him – different to mum

Contrast with father

Zeppelins – bombing raids

Something mysterious about father

A sign of fear!

A sense almost of surprise

What to do next!

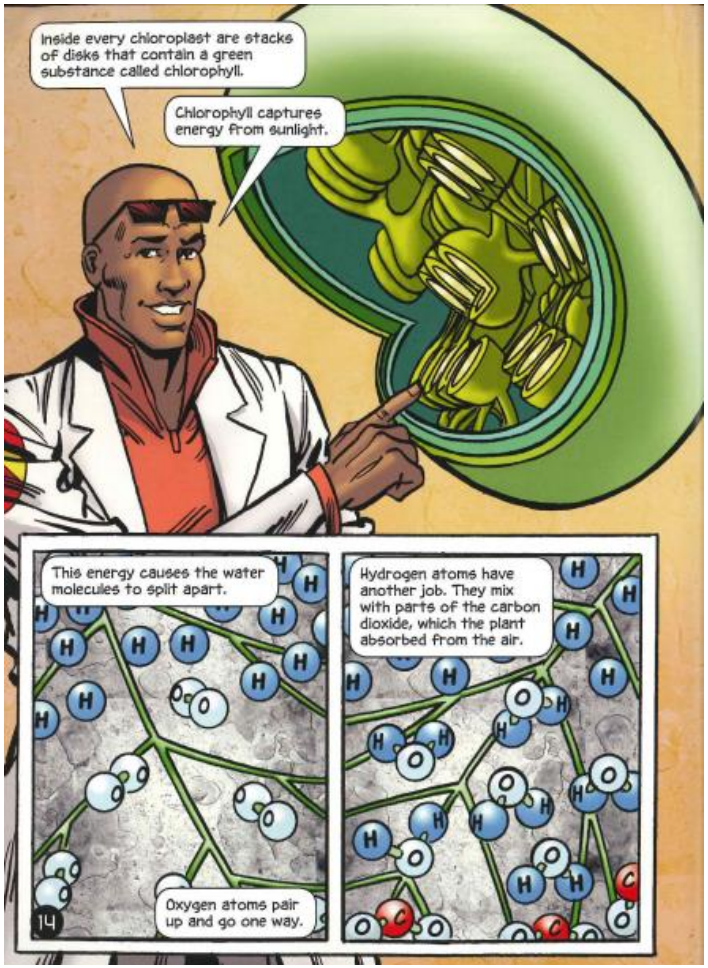
The CCSS and Information Writing

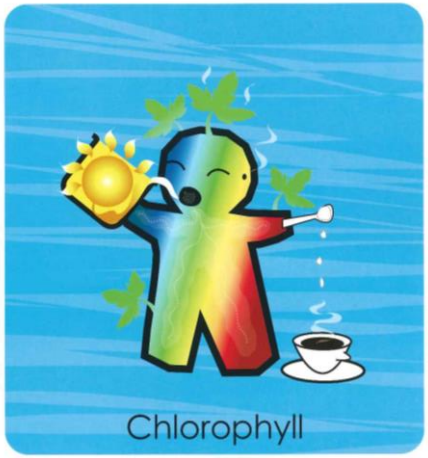
"Information writing includes entries, Post-it notes, summaries written in response to reading, lab reports, math records, and descriptions of and reflections on movies, field trips, and books" (Calkins, 2014)

CCSS, Appendix A

"Informational/explanatory writing includes a wide array of genres, including academic genres such as literary analyses, scientific and historical reports, summaries, and precise writing as well as forms of workplace and functional writing such as instructions, manuals, memos, reports, applications, and resumes" (p.23).

Informational Text Examples





Chlorophyll

Chemicals for Life

- This miracle Molecule has mastered the trick of photosynthesis
- Puts the green in greenery and allows plants to feed and grow
- Grabs sunlight to power these chemical shenanigans

I am the green goddess, the soul of the natural world. In plant leaves, you find me in blobs (or organelles) called chloroplasts—tiny factories producing the food that plants need in order to grow and develop. The key is a chemical reaction called photosynthesis: Water is taken up through the roots and Carbon Dioxide from the air, before they are converted into Oxygen and sugar-food (glucose, a kind of carbohydrate) in the presence of light.

My ability to absorb light is what makes the reaction run so smoothly. You see me as green because I absorb the blue and red frequencies of the visible light spectrum and reflect the green—leaves turn yellow when I break down in the fall. Plants are a food source for most living things. So it's only fair to say that I feed the world!

Photosynthesis: water + carbon dioxide + light → oxygen + glucose

- Chlorophyll "a" formula: $C_{55}H_{72}MgN_4O_5$
- Size of chloroplast: 0.0004 in. x 0.00012 in.
- Used as a food coloring (such as in pasta)

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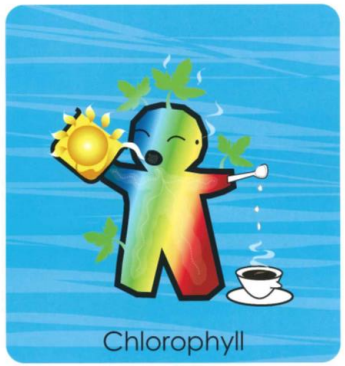
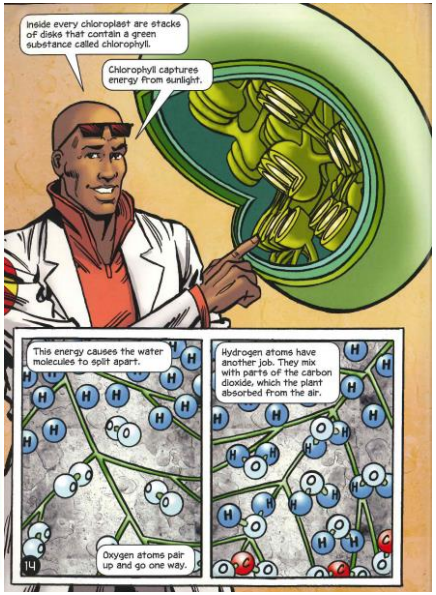
Writing about the Journey

- Write a 1st person narrative or graphic novel.
- Pick one of the main characters in photosynthesis or cellular respiration.
  - Oxygen, carbon dioxide, energy, water, glucose…
- What is the setting of the action?
- What is the plot?





High School
NGSS & Common Core Integration

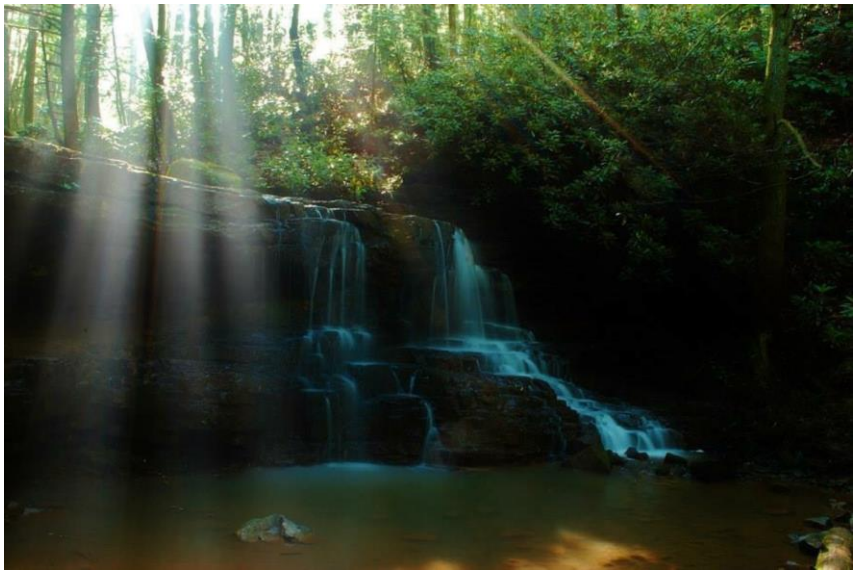
NGSS	Common Core
HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	**RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1),(HS-LS1-6)
HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.	**WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1),(HS-LS1-6) **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6)
HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.	**WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS-1-1),(HS-LS1-6) **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)

Harold’s slides

Photosynthesis and Biomes of Literacy: Chinese/Appalachian Connections

Cherokee High School: Hawkins County, TN

The Landscape: Hawkins County



Chinese/Appalachian Connections

- The southern Appalachian Mountains comprise one of the world's most ecologically important forested regions. Its plant diversity is exceeded only by tropical forests like those of the Amazon River basin. The Appalachians only other rival are temperate broadleaf deciduous forests of southern China.

Yunnan Province and Appalachia: Separated at Birth?

Ecological Similarities …

- Both regions benefit from large canopy trees: oak, hickory, beech, maples, basswood, walnut and cherry. The smaller mid-story trees are also familiar: dogwood, redbud, serviceberry and rhododendron.
- There are only two species of tulip poplars in the world – one in China and one in the eastern U.S. By the way, the tulip poplar is the state tree of TN.
- Two-Thirds of all the wild orchids in Appalachia are cousins to those in China.
- Both forest floors are covered with may-apples, ginseng, and ferns.

But Why? Theories…

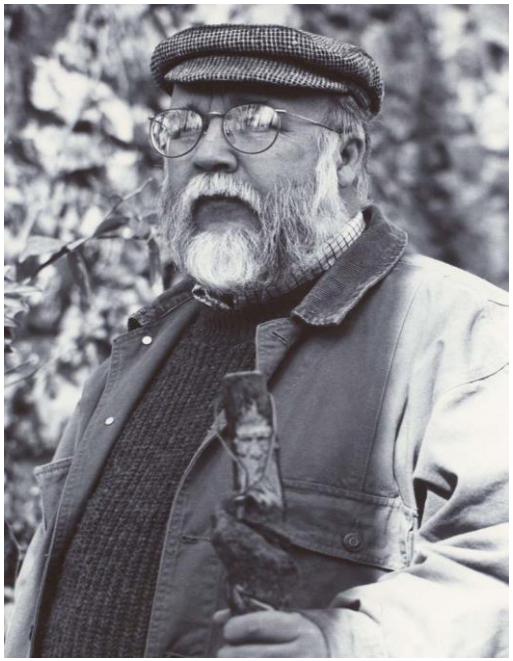
- Neither region suffered from extreme glaciation Pleistocene era.
- “Isolated plants remain as survivors of an ancient circumpolar plant community” (Constantz).

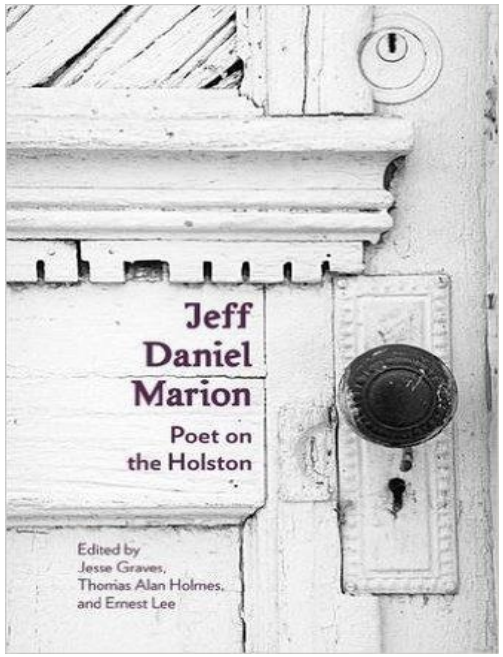
The Poets…

- Li Po 7th Century
- Tu Fu 7th Century
- Han Shan (Cold Mountain) 9th Century

- Charles Wright (Former U.S. Poet Laureate, 2015)
- Mary Oliver
- George Scarborough

Jeff Daniel Marion: Poet on the Holston





Works Cited

- Constanz, George. *Hollows, Peepers, & Highlanders.* Morgantown: West Virginia Press, 2004. Print

Additional Resources

- *Young Reader's Edition The Omnivore's Dilemma: The Secrets Behind What You Eat* by M. Pollan
- *The Omnivore's Dilemma: A Natural History of Four Meals* by M. Pollan
- *The Cartoon Guide to Chemistry* by L. Gonick & C. Criddle
- *Understanding Photosynthesis with Max Axiom Super Scientist* by L. O'Donnell
- *The Basics of Cell Life with Max Axiom Super Scientist* by A. Keyser
- *The World of Food Chains with Max Axiom Super Scientists* by L. O'Donnell
- *The Dynamic World of Chemical Reactions with Max Axiom Super Scientist* by A. Biskup
- *Solar Energy* by D. Armentrout & P. Armetrout
- *The Botany Coloring Book* by P. Young
- *Uncovering Student Ideas in Science* by P. Keeley
- *Chemistry: Getting a Big Reaction!* By D. Green

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