Instructional Moves to Increase Content-Based Literacy in the Science Classroom

San Juan Unified District

Common Core Standards Summer Institute

June 30, 2014

Disciplinary Literacy: A Rationale

Students' linguistic and literacy competencies impact their success in reading, writing, speaking, and listening.

That impact extends to all academic content areas.

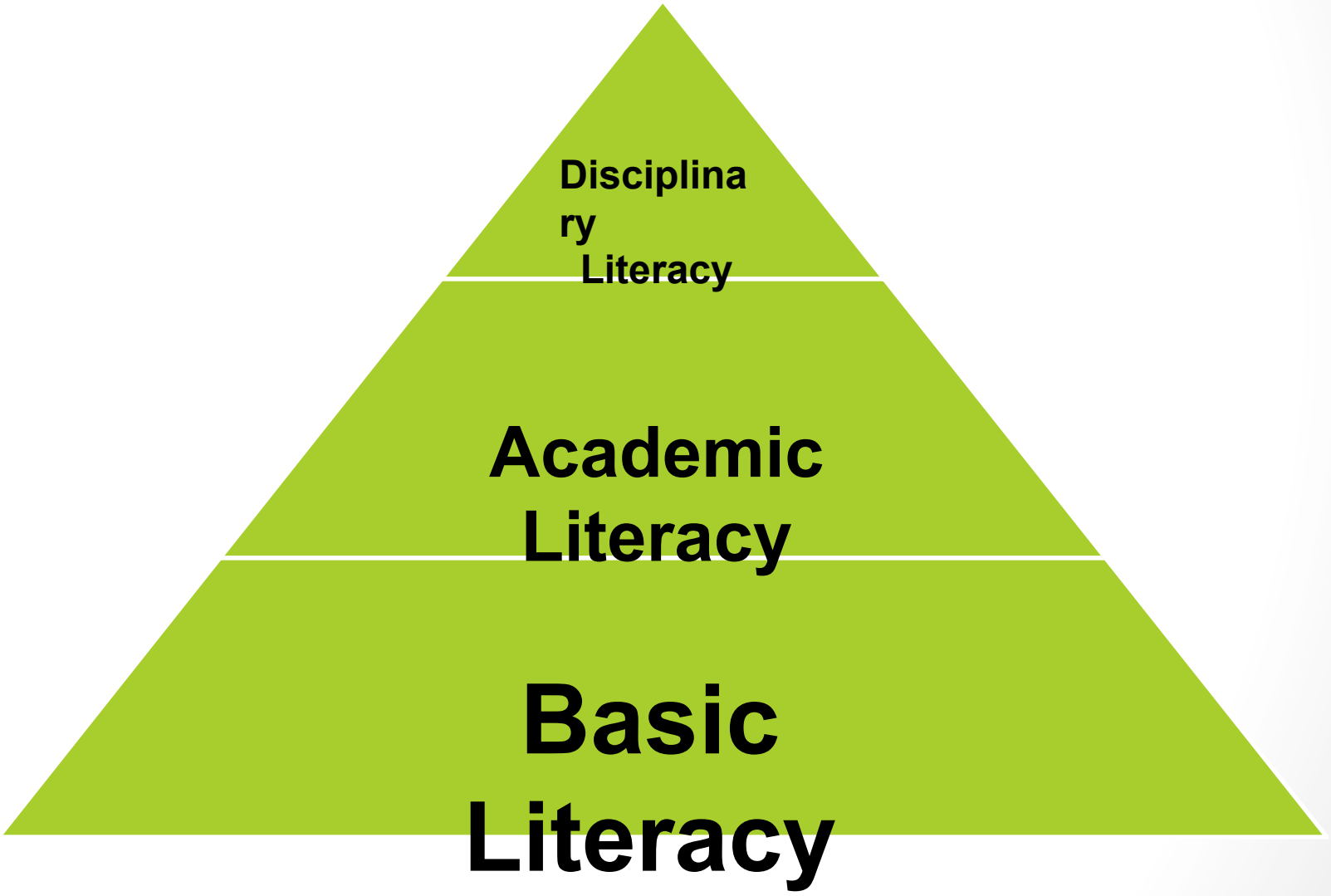
Disciplinary Literacy ….

Necessitates that we conceptualize reading and writing as contextually dependent practices; students are expected to become many different kinds of readers and writers

(Gee, 2000.)

A Model of Disciplinary Literacy

(modified from Shanahan & Shanahan, 2008)



Disciplinary Literacy

Accounts for . . .

The level of reading, writing, and speaking

skills necessary to read, comprehend, and

respond to appropriate instructional

materials in a given subject area.

Disciplinary literacy is distinct from "content area" reading

“Disciplinary literacy is more aimed at what we teach (which would include how to read and use information like a scientist), than how we teach (such as how can students read science text well enough to pass the test). The idea of disciplinary literacy is that students not only have to learn the essential content of a field, **but how reading and writing are used in that field**. On the other hand, content area reading focuses on imparting reading and study skills that may help students to better understand and remember whatever they read.”

Shanahan, 2012

The Content Teacher's Critical Role

1) No one understands the specific content of English language arts, social studies, **science**, and mathematics better than the teacher of that discipline. Content area teachers are the ones who have the knowledge of the reading, writing, listening, discussion, and deep thinking skills that are required to understand content text.

3) Content area teachers have the opportunity to develop students' literacy skills because they see them on a frequent, regular basis and can teach content relevant to reading and writing within the context of a unit of study, promoting engagement and learning.

(Irvin, J., Meltzer, J., & Dukes, M., 2007).

Research Connection Between Science and Literacy: A Natural Fit

Language and Literacy are essential for effective science learning:

- Supports clarity of thought, description, discussion, and argument.
- Students make meaning by writing, talking, and reading about science, especially when accompanied by direct investigation of scientific phenomena.
- The ability to use language to form ideas, theorize, reflect, share, debate, and clearly communicate underpins student acquisition of science concepts and processes.

NSRC, 2012

What must students *do* with language in light of Common Core?

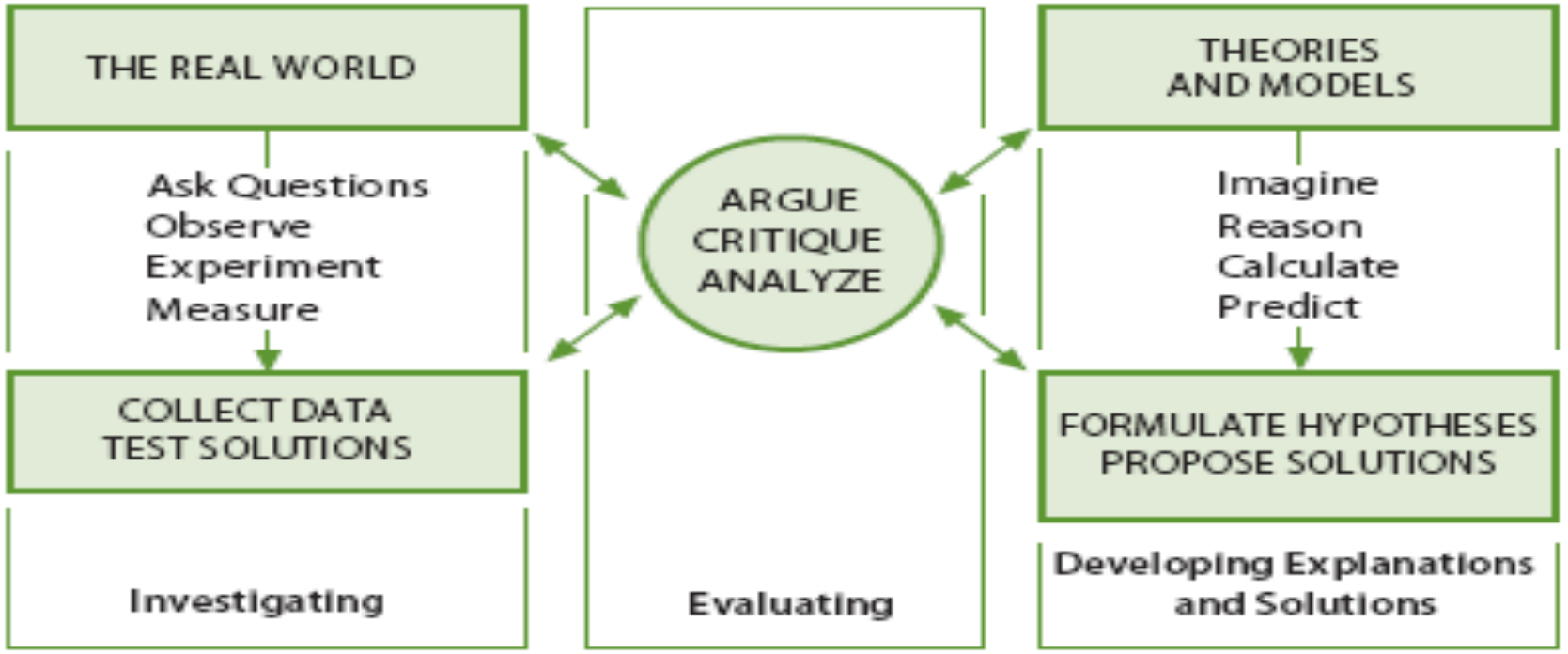


FIGURE 3-1 The three spheres of activity for scientists and engineers.

Among essential science practices:

- ***Constructing explanations*** and designing solutions
- ***Engaging in argument*** from evidence
- Obtaining, evaluating, and ***communicating information***

K-12 Science Framework (NRC, 2012, pp. 45, 49)

Comparison of Skills Science and Reading

SCIENCE

- Observing
- Predicting
- Inferring
- Comparing & Contrasting
- Communicating
- Classifying
- Collecting & Organizing Data
- Interpreting Data
- Linking Cause & Effect
- Formulating Conclusions

READING

- Note Details
- Predicting
- Inferring
- Comparing & Contrasting
- Communicating
- Sequencing
- Summarizing
- Recognizing Main Ideas
- Recognizing Cause & Effect
- Drawing Conclusions

Comparison of Skills Writing and Science

Writing

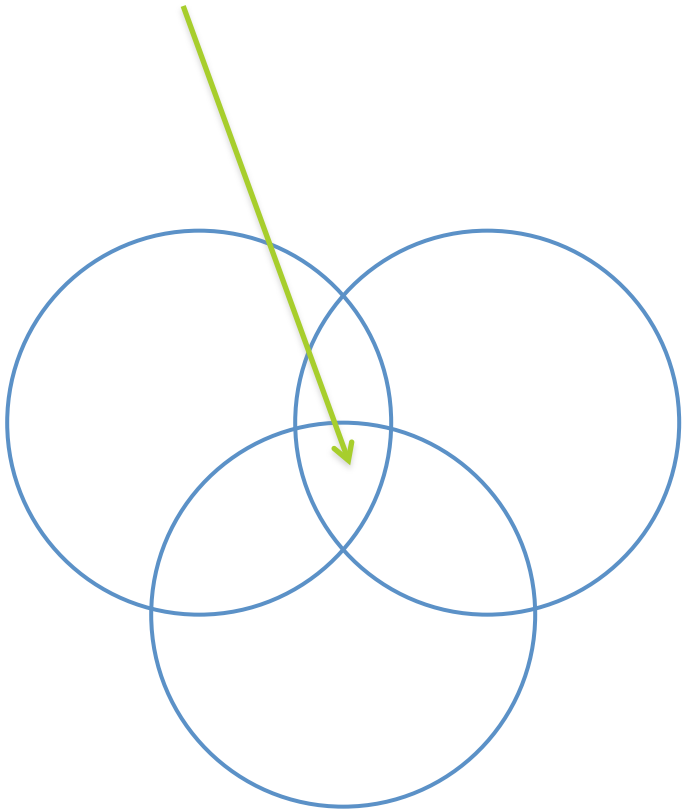
- Compare and contrast
- Analysis
- Persuade and convince
- Cause and effect
- Problems and solutions
- Descriptions and
- Observations
- Summaries

Science

- Interpreting data and graphs
- Annotated diagrams and
- Drawings
- Procedures/processes
- Inferences
- Hypotheses
- Explanations/ justifications
- Conclusions
- Focused free writing

New Opportunities for All Learners

California Common Core State Standards



Next Generation Science Standards

21st Century Skills

What does Disciplinary Literacy look like in a science classroom?

Moving…..

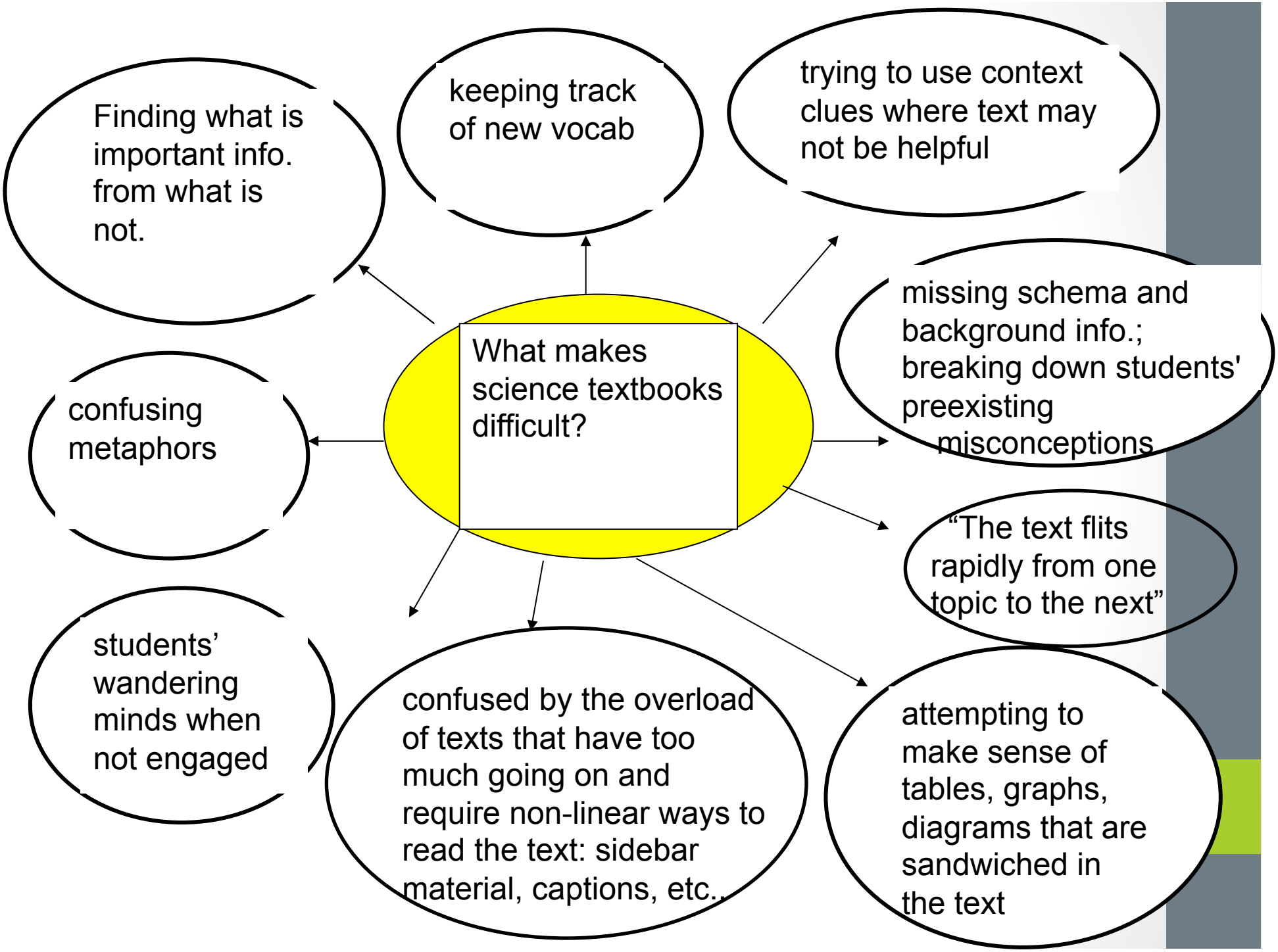
From…..

- Writing from a personal perspective… I think, I feel.
- Teacher interpreting text.
- Reading only textbooks.
- Identification and memorization of facts.
- Using a single text to gather information.

To……

- Evidence -based responses both orally and in writing.
- Students immersed in doing “the work.”
- Increased close reading of a variety of informational texts.
- Analyzing, synthesizing, and critiquing information.
- Multiple sources of information.

What makes science texts demanding/difficult?


What makes science textbooks difficult?
Finding what is important info. from what is not.
keeping track of new vocab
trying to use context clues where text may not be helpful
missing schema and background info.; breaking down students' preexisting misconceptions
confusing metaphors
"The text flits rapidly from one topic to the next"
students' wandering minds when not engaged
confused by the overload of texts that have too much going on and require non-linear ways to read the text: sidebar material, captions, etc..
attempting to make sense of tables, graphs, diagrams that are sandwiched in the text

Disciplinary Text Features: The Demands of Text

- Text Relationships
- Richness of Detail
- Text Structure
- Writing Style
- Vocabulary Density
- Author's Purpose

Planning Worksheet: Analyzing Features of Text Complexity for Instruction and Assessment (adapted from Buehl, 2011 & Hess, 2011)

Text or Text Passage: Nowicki, Stephen. *Biology.* Orlando: Houghton Mifflin Harcourt Publishing Company, 2012.

Genre:: Textbook Chapter

Factors That Influence Text Complexity	Characteristics of this Text	Instructional Supports/ Assessments
Text Relationships (reader's ability to make inferences, background knowledge demands/degree of familiarity with content required, multiple perspectives, embedded citations)		-
Text Structure: External (format and layout of text: to what degree does the text layout support comprehension? e.g., bold key words, references to other texts and/or visuals, inserted definitions, signposts, etc.)		-
Text Structure: Internal (sequence, description, definition, compare/contrast, cause/effect, etc. Science texts tend towards description and explanation)		
Vocabulary Density (word length, word frequency, Tier 2 words (general academic terms), Tier 3 words (specialized, disciplinary vocabulary) levels of meaning-simple, multiple, explicit, implicit)		
Writing Style/Language Features (longer and more varied sentence structure, length, transitions, grammar, conventions, tone/discourse style, word choice)		
Author's Purpose (explicit/implicit, sophistication or complexity of themes or ideas)		

Chapter 2.3 Carbon-Based Molecules

Nowicki, Stephen. *Biology.* Orlando: Houghton Mifflin Harcourt Publishing Company, 2012.

Carbon is often called the building block of life because carbon atoms are the basis of most molecules that make up living things. These molecules form the structure of living things and carry out most of the processes that keep organisms alive. Carbon is so important because its atomic structure gives it bonding properties that are unique among elements. Each carbon atom has four unpaired electrons in its outer energy level. Therefore, carbon atoms can form covalent bonds with up to four other atoms, including other carbon atoms.

TURN AND TALK: What is conceptually demanding about this text? What would students need to know prior to reading in order to make sense of it?

- **See p. 78 in Success in Science for THINK-PAIR-SHARE strategy description**

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Factors That Influence Text Complexity	Characteristics of this Text	Instructional Supports/ Assessments
Text Relationships (reader's ability to make inferences, background knowledge demands/degree of familiarity with content required, multiple perspectives, embedded citations)	**Text relies on background knowledge of atomic structure and elements**	**- Anticipation Guide for determining background knowledge and misconceptions**

Text Relations Instructional Support
Anticipation Guides: A Prereading Activity:

- A series of statements relevant both to what students already know and to materials (reading, discussion) they are going to study. Must be central to the inquiry question
- Catalyst for activating schemata, making personal connections, and stimulating conceptual change
- Statements are “thought-provoking” and often controversial and or debatable

How to create an Anticipation Guides

1. Identify key ideas and information
2. Anticipate counterintuitive and controversial or misconceptions about the topic
3. Devise written statements
4. Write a brief background or intro to the reading
5. Write directions for the reader
6. Students react to each statement independently
7. Can move to small group discussion before whole-class
8. Students read the text with the purpose of finding evidence that confirms, rejects, or elaborates each statement
9. Students rewrite statements to reflect author's intention. In addition, can assign students to pick one question to write about further
10. Lead class in discussion/(re) discovery

Directions: We will be studying Carbon-Based Molecules and their bonding properties. Before reading the text, read the following statements concerning carbon-based molecules. Decide whether you agree or disagree with each statement.
Write "A" for agree, "D" for disagree in the appropriate box on the left marked, "Before Reading."
Be prepared to share your views about each statement by thinking about what you already know. You will share this information with other members of your group before you read the actual text.
Read the text. Mark the text where there is information regarding the anticipation statements.
Look at the statements again. Now that you have more information, do you still agree with your answers ? Write "A" or "D" in the box on the right marked, "After Reading." Note the page number from the text where you found evidence that either does or does not support your initial response.
Write how your response was either confirmed or changes in the "Reaction" box.

Before Reading	Statement	After Reading	p. #	Reaction
1. Agree/ Disagree	Chemical bonds store the energy that is used to make them	1. Agree/Disagree		
1. Agree/ Disagree	All atoms share the same basic structure	1. Agree/Disagree		
1. Agree/ Disagree	An ionic bond is a physical connection between two ions	1. Agree/Disagree		
1. Agree/ Disagree	A hydrogen atom can be an ion or part of a molecule	1. Agree/Disagree		
1. Agree/ Disagree	Bonds or forces exist between particles	1. Agree/Disagree		

Anticipation Guide with Justification (Oral Language)

- ✓Teacher writes the series of statements
- ✓Students read and mark “agree” or “disagree” individually
- ✓Students partner, discuss, come to consensus, write a justification for each statement
- ✓Pairs can join into groups of four and share their opinions

See p. 92 in *Success in Science* for strategy variation, Anticipatory Set

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Text Structure: Internal (sequence, description, definition, compare/contrast, cause/effect, etc. Science texts tend towards description and explanation)		

Surveying the text: Numerous Strategies

- What do you think the text will be about based on the title?
- What do you know about the author? Does this affect the way you read this text/article?
- What is the point of view of the study? What might that indicate about the text/article?
- Is there an index, a glossary, another way to mark new or difficult vocabulary words?

Internal vs. External text structure

External Text Structure
(Sometimes called front matter and end matter)

- A preface
- A table of contents
- Appendixes
- A bibliography
- Indexes
- Title page
- Dedication

External Text Structure Within a Chapter

- Introduction
- Summary
- Headings
- Graphs
- Charts
- Illustrations
- Guide Questions

Internal Text Structure Text Patterns

- Description
- Sequence
- Comparison and Contrast
- Cause and Effect
- Problem and Solution

Signal Words in Text Structure

- Description
- Sequence
- Comparison and Contrast
- Cause and Effect
- Problem and Solution

Graphic Organizers

- Comparison and Contrast Matrix
- Problem and Solution Outline
- Network Tree
- Series of Events
- Semantic (cognitive mapping)
- Study guides based on text patterns

2.3 Carbon-Based Molecules

VOCABULARY
monomer
polymer
carbohydrate
lipid
fatty acid
protein
amino acid
nucleic acid

KEY CONCEPT **Carbon-based molecules are the foundation of life.**

MAIN IDEAS
- Carbon atoms have unique bonding properties.
- Four main types of carbon-based molecules are found in living things.

Connect to Your World

Car manufacturers often build several types of cars from the same internal frame. The size and style of the cars might differ on the outside, but they have the same structure underneath. Carbon-based molecules are similar, but they are much more varied. There are millions of different carbon-based molecules, but they form around only a few simple frames composed of carbon atoms.

MAIN IDEA

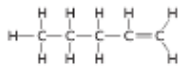
Carbon atoms have unique bonding properties.

Carbon is often called the building block of life because carbon atoms are the basis of most molecules that make up living things. These molecules form the structure of living things and carry out most of the processes that keep organisms alive. Carbon is so important because its atomic structure gives it bonding properties that are unique among elements. Each carbon atom has four unpaired electrons in its outer energy level. Therefore, carbon atoms can form covalent bonds with up to four other atoms, including other carbon atoms.

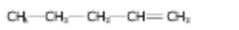
As **FIGURE 3.1** shows, carbon-based molecules have three fundamental structures—straight chains, branched chains, and rings. All three types of molecules are the result of carbon's ability to form four covalent bonds. Carbon chains can bond with carbon rings to form very large, very complex molecules. These large molecules can be made of many small molecules that are bonded together. In a sense, the way these molecules form is similar to the way in which individual links of metal come together to make a bicycle chain.

FIGURE 3.1 CARBON CHAINS AND RINGS

Straight chain

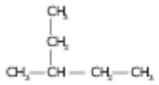


A simplified structure can also be shown as:



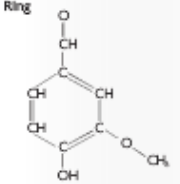
Pentene

Branched chain



Hexane

Ring



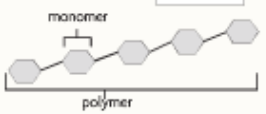
Vanillin

In many carbon-based molecules, small molecules are subunits of an entire molecule, like links in a chain. Each subunit in the complete molecule is called a **monomer.** When monomers are linked, they form molecules called polymers. A **polymer** is a large molecule, or macromolecule, made of many monomers bonded together. All of the monomers in a polymer may be the same, as they are in starches, or they may be different, as they are in proteins.

VISUAL VOCAB

Each smaller molecule is a subunit called a **monomer.**

mono- = one
poly- = many



A **polymer** is a molecule that contains many monomers bonded together.

Synthesize **Write your own analogy for the formation of a polymer from monomers.**

MAIN IDEA

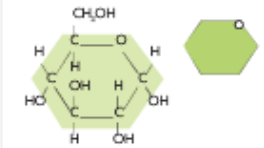
Four main types of carbon-based molecules are found in living things.

All organisms are made of four types of carbon-based molecules: carbohydrates, lipids, proteins, and nucleic acids. These molecules have different structures and functions, but all are formed around carbon chains and rings.

Carbohydrates

Fruits and grains are in different food groups, but they both contain large amounts of carbohydrates. **Carbohydrates** are molecules composed of carbon, hydrogen, and oxygen, and they include sugars and starches. Carbohydrates can be broken down to provide a source of usable chemical energy for cells. Carbohydrates are also a major part of plant cell structure.

The most basic carbohydrates are simple sugars, or monosaccharides (-uh-SAK-uh-). Many simple sugars have either five or six carbon atoms. Fruits contain a six-carbon sugar called fructose. Glucose, one of the sugars made by plant cells during photosynthesis, is another six-carbon sugar. Simple sugars can be bonded to make larger carbohydrates. For example, two sugars bonded together make the disaccharide you know as table sugar, shown in **FIGURE 3.2.** Many glucose molecules can be linked to make polysaccharides (PAHL-ee-SAK-uh-), which are polymers of monosaccharides.



Glucose ($C_6H_{12}O_6$) can be ring shaped and is often shown as a simplified hexagon.

Starches, glycogen, and cellulose are polysaccharides. Starches and glycogen are similar, but they differ from cellulose because their glucose monomers are bonded together differently. Most starches are branched chains of glucose molecules. Starches are made and stored by plants, and they can be broken down as a source of energy by plant and animal cells. Glycogen, which is made and stored in animals, is more highly branched than plant starches.

READING TOOLBOX

TAKING NOTES

Use a content frame to help you understand monomers and polymers in carbon-based molecules.

Monomer	Polymer	Example	Function

FIGURE 3.2 Household sugar (sucrose) is a disaccharide, or two-sugar molecule, of glucose (inset) and fructose.

What external text features (within the chapter) support and/or hinder comprehension?

Internal Text Structure/Text Patterns (and a little Writing style and Author's Purpose)

Carbon is often called the building block of life because carbon atoms are the basis of most molecules that make up living things. These molecules form the structure of living things and carry out most of the processes that keep organisms alive. Carbon is so important because its atomic structure gives it bonding properties that are unique among elements. Each carbon atom has four unpaired electrons in its outer energy level. Therefore, carbon atoms can form covalent bonds with up to four other atoms, including other carbon atoms.

What function does the word, *most* serve in this paragraph?
What function does the modal, can serve in this paragraph

How does the signal word, *therefore* function within the text structure?

What is implied by using a fixed phrase such as "*the building block of life*" ?

Who is telling the reader that carbon is "*so important***"** and "*unique among elements*" **?**

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Text Structure: Internal (sequence, description, definition, compare/contrast, cause/effect, etc. Science texts tend towards description and explanation)	Signal words that support comprehension Includes various text structure types of varying complexity • Definition • Sequence • Cause/Effect	-Annotating/Text Marking/Coding -Model with Think-Aloud -Students practice with complex text passage -Graphic organizer

Text Marking/Coding/Annotations

Text Marking can encompass a variety of strategic actions supporting students' reading comprehension processes.

Opportunities to *highlight, underline and write marginal annotations* allow students to

- determine importance
- identify signal words
- elaborate their understandings
- question
- make connections

However, these strategic actions **must be taught, modeled and practiced (extensively)** so that they may become internalized ways of responding to the demands of text.

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Vocabulary Density (word length, word frequency, Tier 2 words (general academic terms), Tier 3 words (specialized, disciplinary vocabulary) levels of meaning-simple, multiple, explicit, implicit)		
Writing Style/Language Features (longer and more varied sentence structure, length, transitions, grammar, conventions, tone/ discourse style, word choice)	Numerous complex sentences with subordinate clauses, phrases or transition words, often containing multiple concepts	-Chunking -Annotating/Text Marking/Coding
Author's Purpose (explicit/implicit, sophistication or complexity of themes or ideas)	Explicit Purpose	-Annotating/Text Marking/Coding

Annotating to Elaborate and Connect

If a protein has incorrect amino acids, the structure may change* in *a way that prevents the protein from working properly. Just one** wrong amino acid of the 574 amino acids in hemoglobin causes the disorder ***sickle cell anemia*.

*It's cause and effect but there's that qualifier again, "may". That means it may not?

**Still, that seems powerful if just one can cause a disorder.

***I've heard that name before but I don't know what kind of a disorder it is.

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Building Metacognitive Awareness:
Vocabulary Self-Assessment Charts- One Example

Teaching metacognitive skills helps students learn to monitor comprehension and take charge of their own learning (Graves, 1997; Palanscar, 1985).

Self-Assessment Vocabulary Chart: Carbon-Based Molecules

Rating Vocabulary (√) know it well (?) heard of it (!) do not know it at all

Directions: Using the symbols above, read each term and rank how well you know it. Write what you think the word means. Then, after reading and discussing the text, rate yourself again for each vocabulary term and rewrite the definition for more clarity and accuracy.

Word	**Rating Before Instruction**	What I **Think** It Means **Before** Instruction	**Rating After Instruction**	What I **Know** It Means After Instruction
saturated	√	To be soaked or covered in something	√	To reach complete capacity; The act, process, or result of saturating a substance, or of combining it to its fullest extent.
polymer	**?**	Something with plasticity		
carbohydrate	√	Sugar in food		
protein	√	Meats , dairy, nuts		
Covalent	**!**	Something to do with "two" and maybe side-by-side		

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Text Structure: External (format and layout of text: to what degree does the text layout support comprehension? e.g., bold key words, references to other texts and/or visuals, inserted definitions, signposts, etc.)	**Bolded headings** **Bolded key concepts and main ideas** **Visuals, figures** **Highlighted vocabulary** **Inserted definitions** **Formative assessment questions**	-Surveying the Text
Text Structure: Internal (sequence, description, definition, compare/contrast, cause/effect, etc. Science texts tend towards description and explanation)	**Signal words that support comprehension** **Includes various text structure types of varying complexity** • **Definition** • **Sequence** • **Cause/Effect**	-Annotating/Text Marking/Coding -Model with Think- Aloud -Students practice with complex text passage -Graphic organizer
Vocabulary Density (word length, word frequency, Tier 2 words (general academic terms), Tier 3 words (specialized, disciplinary vocabulary) levels of meaning-simple, multiple, explicit, implicit)	**Includes Tier 2 words: (nonpolar, saturated, disorder, catalyze)** **And Tier 3:** **(monomer, polymer, carbohydrate, lipid, fatty acid, protein, amino acid nucleic acid, *Covalent, carboxyl, hemoglobin, sickle cell anemia*)**	-Word Sorts -Vocabulary Knowledge Rating Sheets -Cubing,
Writing Style/Language Features (longer and more varied sentence structure, length, transitions, grammar, conventions, tone/discourse style, word choice)	Numerous complex sentences with subordinate clauses, phrases or transition words, often containing multiple concepts	-Chunking -Annotating/Text Marking/Coding
Author's Purpose (explicit/implicit, sophistication or complexity of themes or ideas)	Explicit Purpose	-Annotating/Text Marking/Coding

Now it's your turn

Using the sample text, identify the language and literacy demands. Use the blank planning guide to document the different types of demands and features the text presents (middle column only for now.)

"reading like a scientist"

- The CA CCSS in ELA/Literacy emphasize synthesis, evaluation, and comparative textual analysis. Across all grade levels, the reading standards one through nine are designed to help students acquire the skills to comprehend the text, follow an author's reasoning, to analyze claims and to support those claims with evidence from the text.

- One shift in the CA CCSS in ELA/Literacy is to infuse rigor in the content areas by having students read increasingly complex texts, which will support them in their scientific reading and writing.

- However, an issue in science instruction is finding *meaningful* text for students to read. A textbook limits how information is presented. Using additional primary source materials, science journals and magazines, provides a variety of complex texts that deepen student understanding of science content.