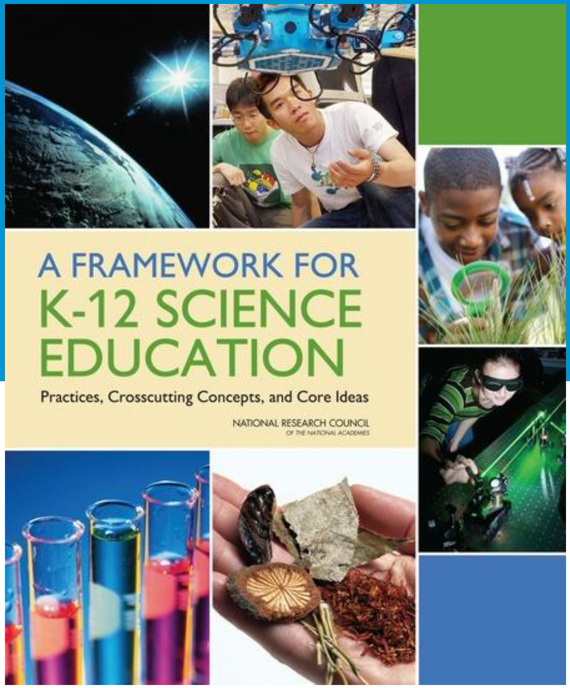
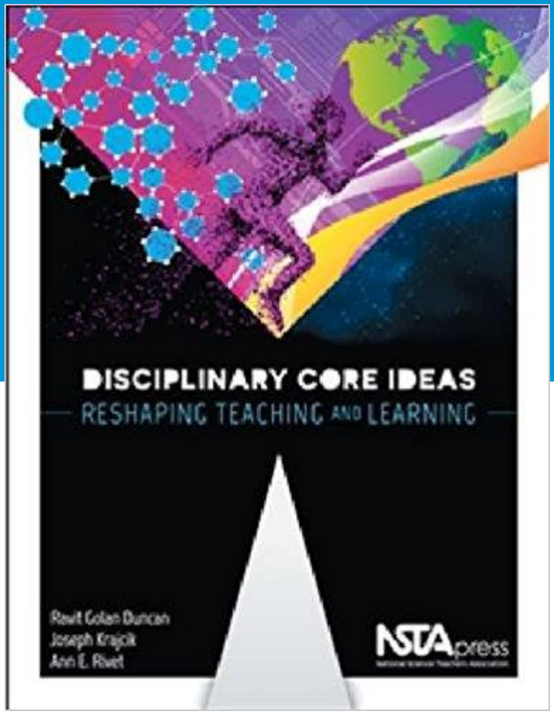
Digging into the Disciplinary Core Ideas





Presentation adapted from the CA Academy of Sciences

Actually…

understanding the NGSS is a

"piece of cake"!

Understanding the NGSS is a piece of cake

Performance Expectation

Baking Tools & Techniques

Science & Engineering Practices

Cake

Disciplinary Core Ideas

Frosting

Crosscutting Concepts

Adapted from NSTA

Understanding the NGSS is a piece of cake

Performance Expectation

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Crosscutting Concepts

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No more "mile wide, inch deep"

"…the framework focuses on a ***limited number of core ideas****... Reduction of the sheer sum of details to be mastered is intended to* ***give time*** *for students to engage in scientific investigations and argumentation and to achieve* ***depth of understanding*** *of the core ideas presented."*

"…our effort to identify a small number of core ideas ***may disappoint some scientists and educators*** *who find little or nothing of their favorite science topics included in the framework.*

*…****students will leave school better grounded in scientific knowledge and practices*** *than when instruction 'covers' multiple disconnected pieces of information that are memorized and soon forgotten once the test is over."*

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. *Appendix E: Progressions within the Next Generation Science Standards*. Washington, DC: The National Academies Press.

Learning as a progression

"[The framework] is built on the notion of learning as a developmental progression. It is designed to help children continually build on and revise their knowledge and abilities."

SCIENCE!

Disciplines

SCIENCE!

PS	LS	ESS	ETS

Disciplines

Disciplinary Core Ideas

DCIs

Disciplinary Core Ideas (DCIs)

Core ideas should:

1. Have broad importance across multiple sciences or engineering disciplines or be a key organizing principle of a single discipline

2. Provide a key tool for understanding or investigating more complex ideas and solving problems.

3. Relate to the interests and life experiences of students or be connected to societal or personal concerns

4. Be teachable and learnable over multiple grades at increasing levels of depth and sophistication

National Research Council (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington DC: The National Academies Press

Disciplinary Core Ideas (DCIs)

Physical Sciences (PS)	Life Sciences (LS)
PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves and Their Applications in Technologies for Information Transfer	LS1: From Molecules to Organisms: Structures and Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS3: Heredity: Inheritance and Variation of Traits LS4: Biological Evolution: Unity and Diversity
Earth & Space Sciences (ESS)	**Engineering & Technology (ETS)**
ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity	ETS1: Engineering Design ETS2: Links Among Engineering, Technology, Science, and Society

National Research Council (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington DC: The National Academies Press

Disciplinary Core Ideas

DCIs

SCIENCE!

PS				LS				ESS			ETS	
PS1	PS2	PS3	PS4	LS1	LS2	LS3	LS4	ESS1	ESS2	ESS3	ETS1	ETS2
PS1.A PS1.B PS1.C	PS2.A PS2.B PS2.C	PS3.A PS3.B PS3.C PS3.D	PS4.A PS4.B PS4.C	LS1.A LS1.B LS1.C LS1.D	LS2.A LS2.B LS2.C LS2.D	LS3.A LS3.B	LS4.A LS4.B LS4.C LS4.D	ESS1.A ESS1.B ESS1.C	ESS2.A ESS2.B ESS2.C ESS2.D ESS2.E	ESS3.A ESS3.B ESS3.C ESS3.D	ETS1.A ETS1.B ETS1.C	ETS2.A ETS2.B

Component Ideas

OUR NEW SCIENCE STANDARDS

» **How are the DCIs represented in our standards?**

» **TN Academic Standards for Science Packet**

- DCIs and component ideas - page 4-6
- Structure of the standards – page 8
- DCIs across grade levels – page 12-13

» **TN Science Standards Reference Guide**

- DCI Core Idea K-8 Progression – page 4-19
- Locate a standard at your grade level/subject from the reference guide. The reference guide includes the following information by standard:
  - Component Idea
  - Explanation – this focus of the standard, examples, and sometimes boundary statements (Description of what is not addressed at that grade level. Such as *students are not responsible for*… or …*beyond the scope*…)
  - Crosscutting Concept (*suggested*)
  - Science and Engineering Practice (*suggested*)

Example Standard from TN Science Standards Reference Guide
2nd grade Physical Science, page 57

2.PS2.3	Recognize the effect of multiple pushes and pulls on an object's movement or non-movement. **<u>COMPONENT IDEA:</u>** *C. Stabilitiy and Instability in Physical Systems*	**EXPLANATION:** Students should consider instances of objects at rest and in motion and form explanations for causes of rest or motion. Force diagrams are a powerful model which can be used to help student create explanations for why some objects may slide down a slope, while other objects might remain at rest on the same slope. Objects might also include those suspended from vertical wires or those resting against a wall. Using the bristled portion of a broom, sweep across the top of a bowling ball to change its motion and observe the forces/sweeps required to cause the bowling ball to follow certain paths (e.g., around a circle, through a maze). *(Students can use symbols such as arrows of different sizes/lengths to represent relative sizes of forces without actual measurements.)*	**<u>CROSSCUTTING CONCEPT:</u>** **Stability and Change** *Students begin to question causes for stability and change and why some systems do not change.* **<u>SCIENCE AND ENGINEERING PRINCIPLE:</u>** **Constructing explanations and designing solutions** *Students generate explanations for natural phenomena that incorporate relevant evidence.*

Example Standard from TN Science Standards Reference Guide
5th grade Physical Science, page 111

5.PS2.2	Make observations and measurements of an object's motion to provide evidence that pattern can be used to predict future motion. **COMPONENT IDEA:** *C. Stability and Instability in Physical Systems*	**EXPLANATION:** The focus of this standard is to provide students with the opportunity to observe motion that occurs in cycles and use an understanding of these cycles to make future predictions. This type of motion is called simple harmonic motion. Examples might include any variety of pendulum, a see-saw or objects traveling circular paths such as a carousel. (Instruction should focus on the forces required to create periodic motion and how these forces change, but not emphasize technical terms such as period.)	**Crosscutting Concept:** **Pattern** *Students recognize, classify, and record patterns involving rates of change.* **SCIENCE AND ENGINEERING PRINCIPLE:** **Developing and using models** *Student models begin to become abstract and metaphorical, incorporating relationships between events and predictive aspects for recurring events.*

Example Standard from TN Science Standards Reference Guide
7th grade Life Science, page 155

7.LS3.2	Distinguish between mitosis and mitosis and meiosis and compare the resulting daughter cells. **<u>COMPONENT IDEA:</u>** *B. Variation of Traits*	**EXPLANATION:** The process of sexual reproduction produces one set of genetic information for an offspring (with two copies of most genes) where each parent has contributed half of the genetic information (one copy of each gene). The focus of this standard is not on the memorization of the specific names of phases of cell reproduction, but on developing an understanding of how daughter cells compare between each process. The stages of either process may be used in support during instruction. For example, students could trace a single chromosome through the process, noticing that each of the new sex cells produced are genetically different from the parent cell based on two divisions and half the DNA. *(This standard does not anticipate that students will memorize the names of the phases of mitosis/meiosis.)*	**<u>CROSSCUTTING CONCEPT:</u>** **Cause and Effect** *Students infer and identify cause and effect relationships from patterns.* **<u>SCIENCE AND ENGINEERING PRINCIPLE:</u>** **Developing and using models** *Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models.*

Example Standard from TN Science Standards Reference Guide Biology, page 190

<table>
<tr><th colspan="4">BIO1.LS3: Heredity</th></tr>
<tr>
<td rowspan="2">BIO1.LS3.1</td>
<td rowspan="2">Model chromosome progression through meiosis and fertilization in order to argue how the process of sexual reproduction leads to both genetic similarities and variation in diploid organisms. Compare and contrast the processes of sexual and asexual reproduction, identifying the advantages and disadvantages of each.

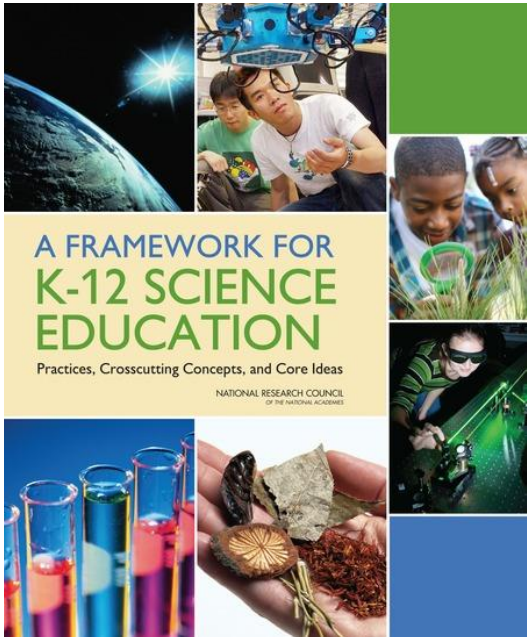
<u>Component Idea:</u>
B. Variation of Traits</td>
<td rowspan="2">Explanation: In 7.LS2.8, students develop an understanding that organisms grow from a single cell to a potentially complex multicellular organism through mitosis. It is critical to note that meiosis is introduced in 7.LS3.2 with the sole purpose to focus on the resulting daughter cells. Meiosis related content is categorized under LS3. While meiosis can be viewed as a unique form of cell division that provides a mechanism that results in offspring with a genotype unique unto itself. It should be recognized that mutations are the primary source of variation created through asexual reproduction by mitosis or binary fission and that mutations are passed to sexually reproduced offspring only when they are present in gametes. Attention should be drawn to the idea that population diversity must be advantageous considering the disadvantages of sexual reproduction (partner requirement and increased energy requirement). Meiosis and fertilization can be modeled with diagrams, 3D models, animations, etc. An emphasis should be placed on events that lead to genetic differences (mutations, crossing over, and random segregation) as well as events that generate similarities in parent and offspring (DNA replication and transmission). Similarities and differences in sexual and asexual reproductive strategies can be compiled and analyzed by students through the use of comparative models previously used (BIO1.LS1.5) and/or other resources (text, video, etc). These models may further be used to demonstrate how chromosomal-based diseases such as Trisomy 21 (Down syndrome) occur and/or how sterile hybrids, such as mules or seedless watermelons, cannot effectively complete meiosis due to non-homologous chromosomes from different parent species.</td>
<td><u>Crosscutting Concept:</u>
Cause and Effect
Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.</td>
</tr>
<tr>
<td><u>Science and Engineering Principle:</u>
Developing and using models
Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system.</td>
</tr>
</table>

How can we unpack our standards further?

Use **A Framework for K-12 Science Education**

» **Grades K-5, Chapter 5 DCI – Physical Sciences, p. 103**

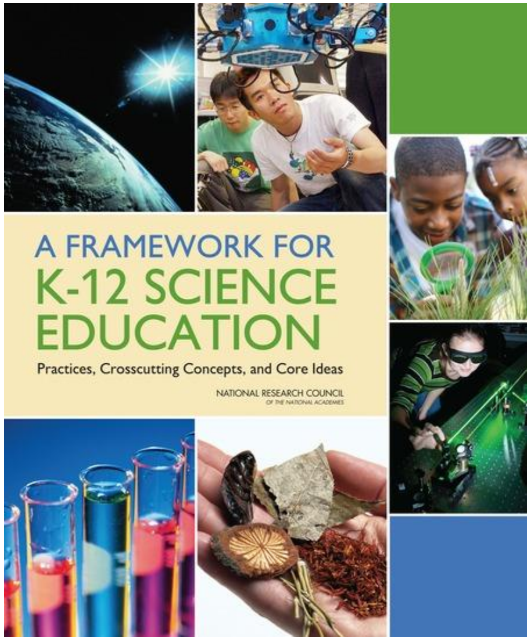
- **Skim intro to chapter, p. 103-105**
- **Skip to Core Idea PS2: Motion and Stability: Forces and Interactions, p. 113**
    - **Skip to the Component Idea PS2C: Stability and instability in physical systems p. 118-120. Read & discuss.**



How can we unpack our standards further?

Use **A Framework for K-12 Science Education**

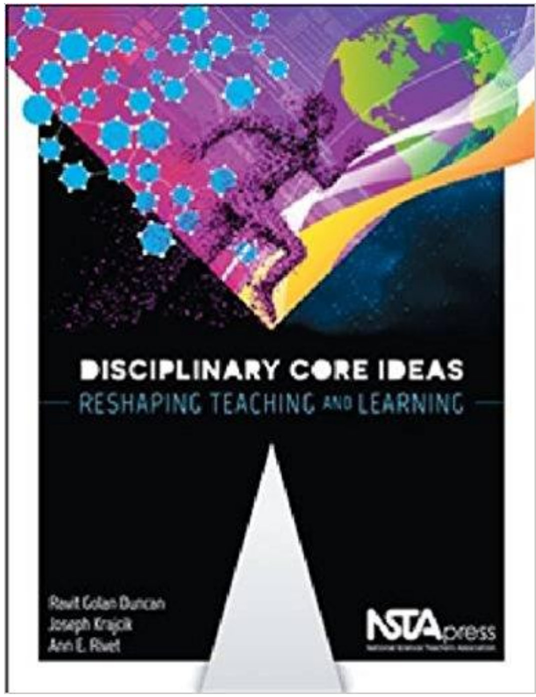
» **Grades 6-12, Chapter 6 DCI – Life Sciences, p. 139**
  - **Skim intro to chapter, p. 139-142**
  - **Skip to Core Idea LS3: Inheritance and Variation of Traits, p. 157-158. Read Intro.**
    - **Skip to the Component Idea LS3B: Variation of Traits p. 160-161. Read & discuss.**



What if you need more information?

Disciplinary Core Ideas: Reshaping Teaching and Learning

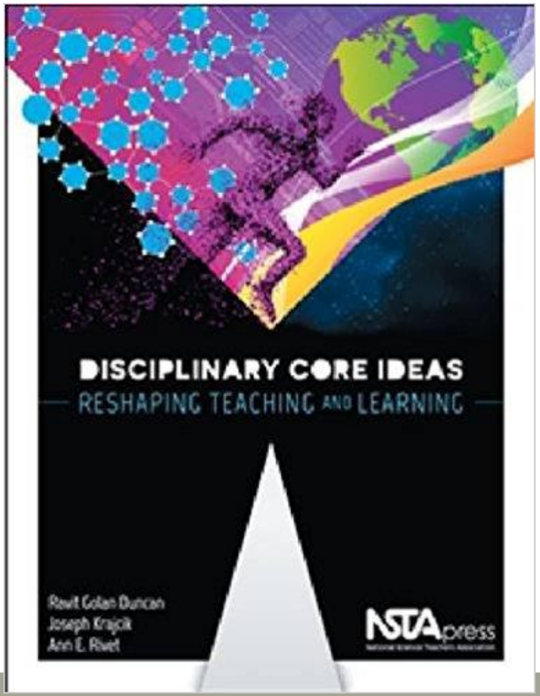
» Use this text to explore the following content for each disciplinary core idea and associated component ideas
  - Major ideas & terminology
  - Prior knowledge needed to achieve understanding
  - Student challenges
  - Methods to determine students' current understandings
  - Ways instruction can address or leverage understanding
  - Ideas to incorporate phenomena



What if you need more information?

Disciplinary Core Ideas: Reshaping Teaching and Learning

- **Grades K-5, Chapter 3, Core Idea PS2, Motion & Stability: Forces & Interactions, skim page 103**
- **Component Idea PS2C – Stability and Instability in Physical Systems, p. 44**
- **How does student understanding of this core idea develop over time? Possible tasks.**
  - **By the end of grade 2, p. 45**
  - **By the end of grade 5, p. 47-48**
  - **By the end of grade 8, p. 50-51 (skim)**
- **What suggestions for phenomena do you see?**



What if you need more information?

Disciplinary Core Ideas: Reshaping Teaching and Learning

» **Grades 6-12, Chapter 8, Core Idea LS3, Inheritance and Variation of Traits, p. 145-146 skim up to *Why is this Core Idea Important?***

» **Component Idea LS3B – Variation of Traits. P. 151-154**

» **How does student understanding of this core idea develop over time?**
  - **Middle Grades, p. 156-157**
  - **High School, p. 158**
  - **See Table 8.1 on page 157 for K-12 progression**

» **Challenges to Student Understandings, p. 158-159**

» **Approaches to Teach this DCI, p. 160-161**
  - **What suggestions do you see for phenomena?**