Advancing Youth Scientific Literacy:
Strategies to Develop Knowledge and Skills to Help Youth Make Healthy Choices

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Scientific Literacy and 21st Century Society

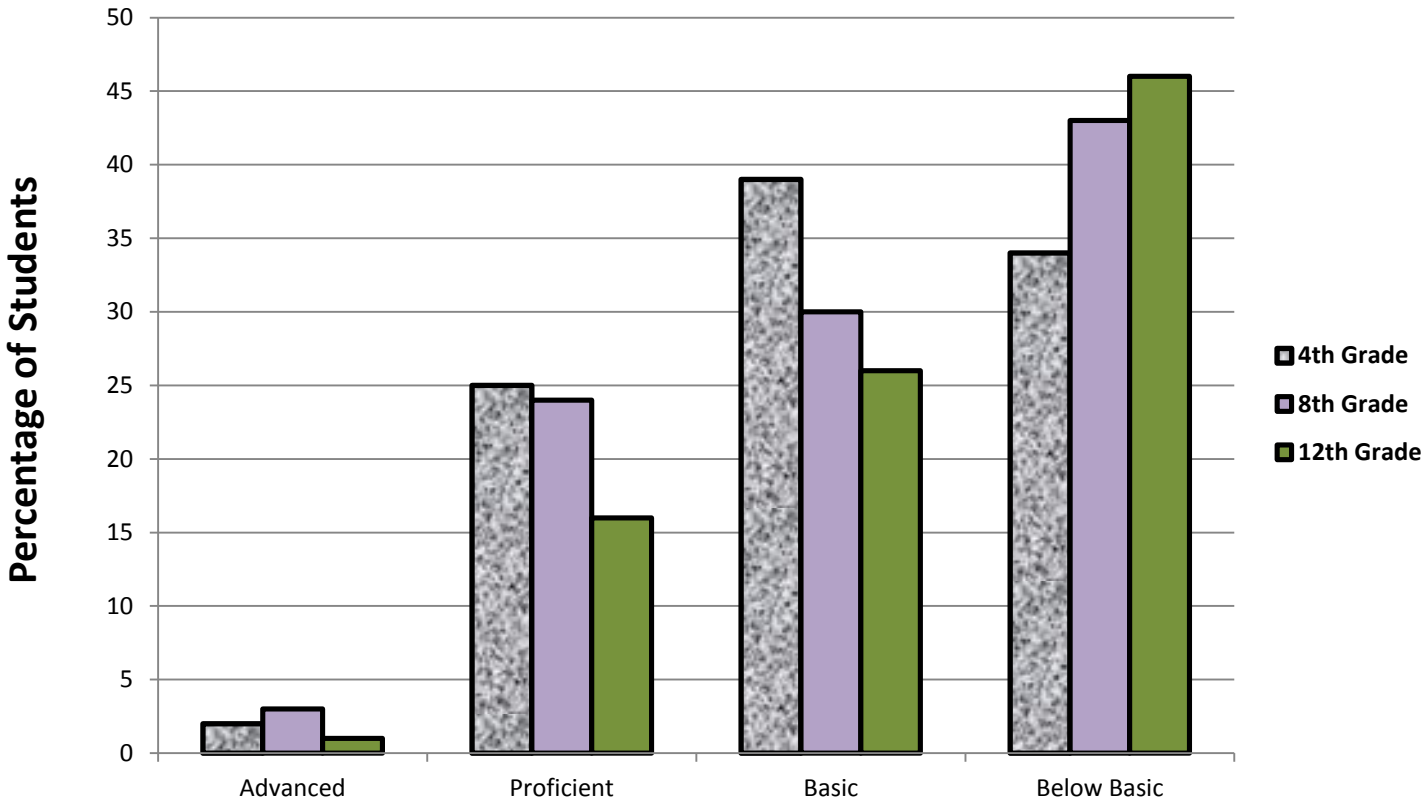
- **Scientific Literacy**: Having a fundamental understanding of scientific concepts and theories and the capacity to use scientific thinking to address important societal challenges (AAAS, 1990; Miller, 2006; Perkins-Gough, 2006/2007).
- 21st century society is greatly dependent upon a scientifically literate population. Issues associated with science include key public policy decisions (e.g., stem cell research and global warming) and personal consumer choices (e.g., medicine and nutrition).

Adult Scientific Literacy

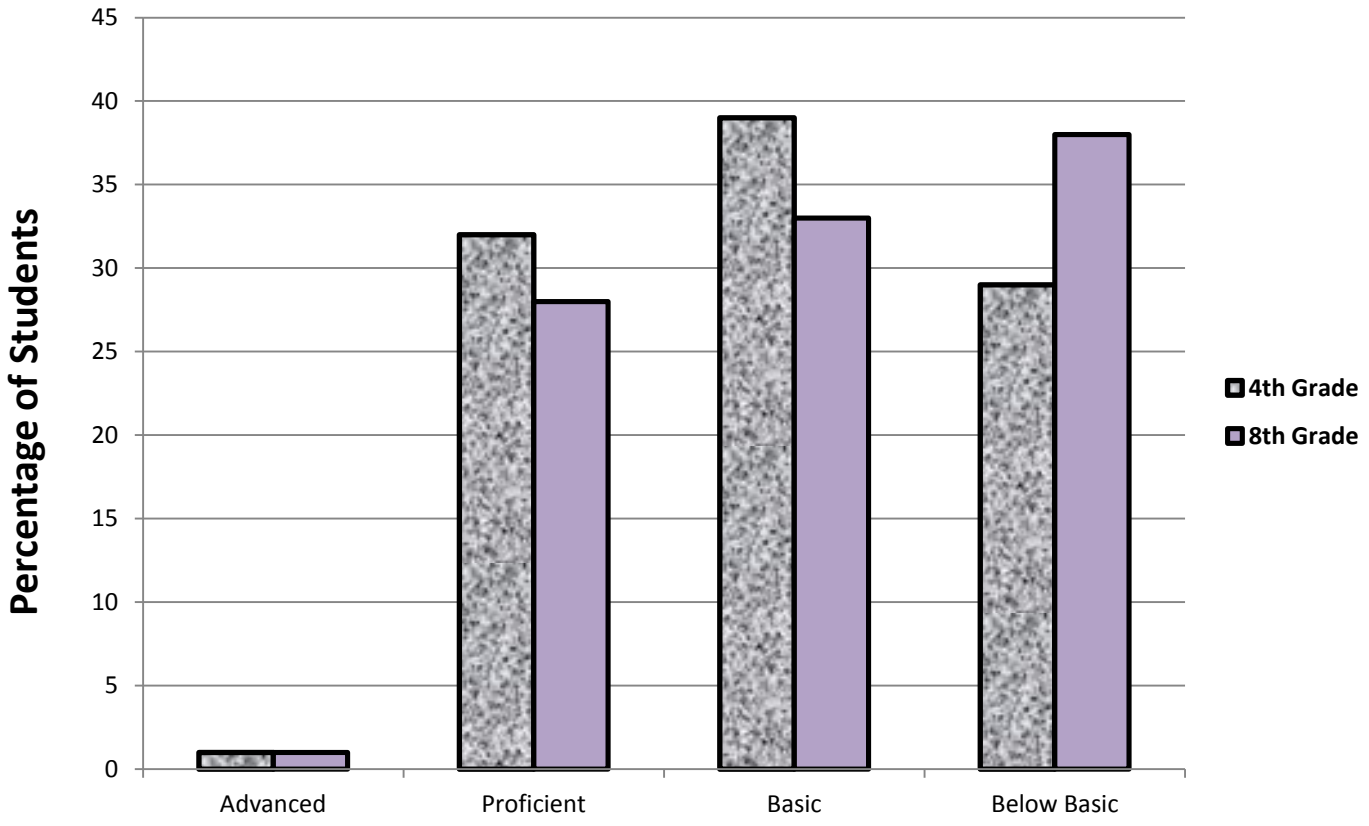
- Current levels of adult scientific literacy are considered inadequate (California Academy of Sciences, 2009). Miller (2006) estimates that only 28% of the adults in the U.S. are scientifically literate.
- Deficits in science literacy places individual in jeopardy of not having the requisite knowledge and skills for successful careers and comprehensive engagement in today's society.
- Deficits also impede the nation's ability to remain scientifically competitive within the international community (National Academy of Sciences, 2007).

Youth Scientific Literacy: The National Picture

- Results from the 2005 and 2009 National Assessment of Educational Progress (NAEP) for 4th, 8th, and 12th graders have revealed poor science achievement at all three grade levels (Grigg, Lauko, and Brockway 2006; NCES 2011).
  - In 2005 & 2009, approximately 70% of students at all grade levels scored at the "Basic" or "Below Basic" levels.
  - "Advanced Proficiency" was 3% or less at all grade levels in 2005 & 2009.
- Trends are not distributed equally across the population:
  - Caucasian and Asian American outperformed African Americans & Latinos.
  - Youth from high-income households scored higher than their peers from low-income households.
- Overall, California students scored below national averages on the NAEP assessments, ranking 48th and/or 49th among all states.



Summary Results
2005 National Assessment of Education Progress (NAEP)
Students in Grades 4, 8, and 12.



Summary Results
2009 National Assessment of Education Progress (NAEP)
Students in grades 4 and 8.

Low Levels of Youth Scientific Literacy: Associated Concerns

- K-12 students who score below basic levels will lack the foundational knowledge and skills necessary for scientific careers and full participation in today's knowledge society (National Academy of Sciences, 2007).
  - Declining number of college students in the U.S. who earn undergraduate degrees in science.
  - Decreased production of new scientific knowledge by scientists in the United States.
  - Decreased availability of qualified workforce.
  - Decreased capacity to use **knowledge** and scientific thinking (**skills**) to address important societal challenges, including key public policy decisions and **personal consumer choices** (e.g., nutrition) (AAAS, 1990; Miller, 2006; Perkins-Gough, 2006/2007).

Strategies to Advance Youth Scientific Literacy

- Pedagogy
- Curriculum Materials
- Educator Professional Development
- Formal, Nonformal, and Informal Learning Environments

Science Pedagogy

- Most science is taught using the **transmission model** of instruction (e.g., lectures, demonstrations).
- Lacks theoretical justification; evidence indicates that it is neither efficient nor effective for teaching science.
- Typically used because this is how teachers were taught.

Science Pedagogy

- Second major instructional practice used in teaching science is the **constructivist model.**
- This model involves learners actively constructing knowledge through interactions with the environment: seeing, hearing, touching, smelling, and tasting.
- Data from their senses allow learners to actively construct meaning.

Constructivism

- **Constructivism**: Knowledge is developed through experiences, interactions between learners and their environment. Each new experience draws upon prior ones, modifying them in some way (Dewey, 1933; Fosnot, 1996).
- Knowledge construction or “meaning making” is learner dependent; it reflects a learner’s developmental stage and the cultural context within which the learning occurs (Starratt, 2001).
- Knowledge is constructed as a result of the development of **schemata** or mental models (Richardson, 2003).
- New information is **assimilated** by the learner. New schemata are formed when new information is encountered existed.
- When new information challenges prior knowledge an adjustment in understanding – **accommodation** – is necessary (Richardson, 2003).

Curriculum Development

- **Inquiry:** A constructivist-based pedagogical approach to teaching and learning that involves problem-solving through the collection and analysis of information.
- **Experiential Learning:** A pedagogical strategy that involves specific components that are part of a recurring cycle: 1) Experience; 2) Reflection; 3) Application.

What is Inquiry?

"Inquiry is a process that all individuals naturally use in approaching new situations and solving problems in life. By engaging in inquiry, …children…gain experience…that will improve their capacity to handle life situations and solve everyday problems."

- Edmund Marek and Ann Cavallo (1997)

Inquiry and Learners

- Active investigation; learners take responsibility for their own learning.
- Open-ended questioning; questions “reside” with the learners.
- Observing and manipulating (mentally or physically) objects, phenomena, and/or nature; and
- The acquisition/discovery of new knowledge.

Inquiry and Educators

- **Learner-Centered Instruction**: Inquiry places educators in the role of being facilitators of learning, rather than a disseminators of known information.
- Allows educators to better understand their learners, what they know, interests they may have, and how their minds work.

What is Experiential Learning?

- A learner-centered pedagogical strategy.
- Promotes a deep understanding of subject matter, critical thinking, and lifelong learning (Eyler, 2009).
- Involves a recurring cycle that includes:
  - Concrete experience
  - Period of reflection
  - Application of learning to new contexts (Enfield et al., 2007).

Experiential Learning

- Intentional design of curriculum activities:
  - **Experience**: Develop an activity whereby learners receive little or no help from the facilitator (e.g., making products or models; role-playing; problem-solving). Create cognitive dissonance (the “groan zone”); opportunities to construct knowledge.
  - Reflection:
  - Application:

Experiential Learning

- Intentional design of curriculum activities:
  - Experience:
  - **Reflection**: Discuss the experience. Share results, reactions, and observations; identify themes, problems, and issues; connect to real-world examples. *Reflective thought is considered to be truly educative.*
  - Application:

Experiential Learning

- Intentional design of curriculum activities:
  - Experience:
  - Reflection:
  - **Application**: Learners apply new knowledge and skills to authentic, real-world situations. Application is where “the rubber meets the road,” and is what makes learning last.

Nutrition to Grow On: Inquiry-Based Supplement

- *Introduction to Nutrition, Agriculture, and Gardening*
- *Getting Physically Active*
- *Nutrients We Need*
- *Serving Sizes*
- *MyPlate*
- *Food Labels*
- *Consumerism*
- *Making Healthy Snacks*


DAIRY A
Nutrition Facts
Serving Size 21g
Servings Per Container 1
Amount per Serving
Calories 70
Calories from Fat 45
% Daily Value*
Total Fat 5g 8%
Saturated Fat 3g 15%
Trans Fat 0g
Cholesterol 20mg 7%
Sodium 270mg 11%
Total Carbohydrate 2 1%
Dietary Fiber 0g 0%
Sugars 1g
Protein 4g
Vitamin A 4% • Vitamin C 0%
Calcium 25% • Iron 0%
*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.
Calories 2,000 2,500
Total Fat Less than 65g 80g
Saturated Fat Less than 20g 25g
Cholesterol Less than 300mg 300mg
Sodium Less than 2,400 mg 2,400mg
Total Carbohydate 300g 375g
Dietary Fiber 25g 30g


DAIRY B
Nutrition Facts
Serving Size 1/2 cup (66g)
Servings Per Container 4
Amount per Serving
Calories 137
Calories from Fat 65
% Daily Value*
Total Fat 7g 11%
Saturated Fat 4g 22%
Trans Fat 0g
Cholesterol 29mg 10%
Sodium 53mg 2%
Total Carbohydrate 16g 5%
Dietary Fiber 0g 2%
Sugars 14g
Protein 2g
Vitamin A 6% • Vitamin C 1%
Calcium 8% • Iron 0%
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Calories 2,000 2,500
Total Fat Less than 65g 80g
Saturated Fat Less than 20g 25g
Cholesterol Less than 300mg 300mg
Sodium Less than 2,400 mg 2,400mg
Total Carbohydate 300g 375g
Dietary Fiber 25g 30g


DAIRY C
Nutrition Facts
Serving Size 1 cup (250g)
Servings Per Container 1
Amount per Serving
Calories 157
Calories from Fat 22
% Daily Value*
Total Fat 3g 4%
Saturated Fat 2g 8%
Trans Fat 0g
Cholesterol 8mg 3%
Sodium 152mg 6%
Total Carbohydrate 26g 9%
Dietary Fiber 1g 5%
Sugars 25g
Protein 8g
Vitamin A 10% • Vitamin C 4%
Calcium 29% • Iron 3%
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Calories 2,000 2,500
Total Fat Less than 65g 80g
Saturated Fat Less than 20g 25g
Cholesterol Less than 300mg 300mg
Sodium Less than 2,400 mg 2,400mg
Total Carbohydate 300g 375g
Dietary Fiber 25g 30g

FRUIT A

Nutrition Facts

Serving Size 149g
Servings Per Container 1

Amount per Serving

Calories 77	Calories from Fat 2
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 1mg	0%
Total Carbohydrate 21g	7%
Dietary Fiber 4g	14%
Sugars 15g	
Protein 0g	

Vitamin A 2%	•	Vitamin C	11%
Calcium 1%	•	Iron	1%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

FRUIT B

Nutrition Facts

Serving Size 1/2 cup (98g)
Servings Per Container 2

Amount per Serving

Calories 73	Calories from Fat 1
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 6mg	0%
Total Carbohydrate 20g	7%
Dietary Fiber 1g	5%
Sugars 18g	
Protein 0g	

Vitamin A 7%	•	Vitamin C	5%
Calcium 0%	•	Iron	1%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

FRUIT C

Nutrition Facts

Serving Size 43g
Servings Per Container 1

Amount per Serving

Calories 129	Calories from Fat 2
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 5mg	0%
Total Carbohydrate 34g	11%
Dietary Fiber 2g	6%
Sugars 25g	
Protein 1g	

Vitamin A 0%	•	Vitamin C	2%
Calcium 2%	•	Iron	4%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

GRAINS A

Nutrition Facts

Serving Size 2 slices (76g)
Servings Per Container 8

Amount per Serving

Calories 180 Calories from Fat 20

	% Daily Value*
Total Fat 2g	**4%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 270mg	**12%**
Total Carbohydrate 36g	**12%**
Dietary Fiber 4g	**16%**
Sugars 6g	
Protein 8g	

Vitamin A 0% • Vitamin C 0%
Calcium 8% • Iron 12%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

GRAINS B

Nutrition Facts

Serving Size 1 cup
Servings Per Container 1

Amount per Serving

Calories 205 Calories from Fat 4

	% Daily Value*
Total Fat 0g	**1%**
Saturated Fat 0g	**1%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 2mg	**0%**
Total Carbohydrate 45g	**15%**
Dietary Fiber 1g	**3%**
Sugars 0g	
Protein 4g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 11%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

GRAINS C

Nutrition Facts

Serving Size 1 (56g)
Servings Per Container 12

Amount per Serving

Calories 223 Calories from Fat 96

	% Daily Value*
Total Fat 11g	**16%**
Saturated Fat 3g	**15%**
Trans Fat 0g	
Cholesterol 7mg	**6%**
Sodium 217mg	**9%**
Total Carbohydrate 28g	**9%**
Dietary Fiber 1g	**5%**
Sugars 11g	
Protein 3g	

Vitamin A 0% • Vitamin C 1%
Calcium 3% • Iron 12%

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	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

PROTEIN A

Nutrition Facts

Serving Size 2 pieces (148g)
Servings Per Container 5

Amount per Serving
Calories 431 Calories from Fat 241

	% Daily Value*
Total Fat 27g	**41%**
Saturated Fat 7g	**35%**
Trans Fat 0g	
Cholesterol 166mg	**55%**
Sodium 755mg	**31%**
Total Carbohydrate 16g	**5%**
Dietary Fiber 0g	**0%**
Sugars 0g	
Protein 30g	

Vitamin A 4% • Vitamin C 0%
Calcium 4% • Iron 9%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

PROTEIN B

Nutrition Facts

Serving Size 3 oz (85g)
Servings Per Container 2

Amount per Serving
Calories 99 Calories from Fat 6

	% Daily Value*
Total Fat 1g	**1%**
Saturated Fat 0g	**1%**
Trans Fat 0g	
Cholesterol 26mg	9%
Sodium 287mg	**12%**
Total Carbohydrate 0g	**0%**
Dietary Fiber 0g	**0%**
Sugars 0g	
Protein 22g	

Vitamin A 1% • Vitamin C 0%
Calcium 1% • Iron 7%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

PROTEIN C

Nutrition Facts

Serving Size 100g
Servings Per Container 4

Amount per Serving
Calories 91 Calories from Fat 10

	% Daily Value*
Total Fat 1g	2%
Saturated Fat 0g	**2%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 449mg	**19%**
Total Carbohydrate 15g	**5%**
Dietary Fiber 5g	20%
Sugars 0g	
Protein 5g	

Vitamin A 0% • Vitamin C 10%
Calcium 3% • Iron 9%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

VEGETABLE A

Nutrition Facts

Serving Size 85g
Servings Per Container 1

Amount per Serving

Calories 30 Calories from Fat 1

	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 66mg	3%
Total Carbohydrate 7g	2%
Dietary Fiber 2g	10%
Sugars 4g	
Protein 1g	

Vitamin A 234% • Vitamin C 4%
Calcium 3% • Iron 4%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

VEGETABLE B

Nutrition Facts

Serving Size 1 cup (72g)
Servings Per Container 1

Amount per Serving

Calories 10 Calories from Fat 0

	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 7mg	0%
Total Carbohydrate 2g	1%
Dietary Fiber 1g	3%
Sugars 1g	
Protein 1g	

Vitamin A 7% • Vitamin C 3%
Calcium 1% • Iron 2%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

VEGETABLE C

Nutrition Facts

Serving Size 85g
Servings Per Container 1

Amount per Serving

Calories 271 Calories from Fat 130

	% Daily Value*
Total Fat 14g	22%
Saturated Fat 3g	17%
Trans Fat 4g	
Cholesterol 0mg	0%
Sodium 165mg	7%
Total Carbohydrate 32g	11%
Dietary Fiber 3g	12%
Sugars 1g	
Protein 3g	

Vitamin A 0% • Vitamin C 4%
Calcium 1% • Iron 6%

*Percent (%) Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or l ower basedon your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400 mg	2,400mg
Total Carbohydate		300g	375g
Dietary Fiber		25g	30g

Food Label Key

Grains A: 2 slices of whole-wheat bread
Grains B: 1 cup of white rice
Grains C: 1 buttermilk waffle

Protein A: 2 pieces of fried chicken (thigh and drumstick)
Protein B: 3 oz canned tuna, light, packed in water, drained
Protein C: 100 grams of refried beans

Vegetable A: 85 grams of baby carrots
Vegetable B: 1 cup of iceberg lettuce
Vegetable C: 1 small order of French fries

Fruit A: 1 small apple
Fruit B: ½ cup of canned peaches with heavy syrup
Fruit C: 1 small box of raisins

Dairy A: 1 slice American cheese
Dairy B: ½ cup vanilla ice cream
Dairy C: 1 cup chocolate milk, low fat

Experiential Learning & Inquiry

- Describe:
  - Experience: *Opportunities for Inquiry?*
  - Reflection: *Opportunities for reflective thought?*
  - Application: *Explain <u>your</u> ideas for application opportunities.*

"No single learning experience has a very profound influence upon the learner" (Tyler, 1949, p. 83).
Subject matter must be organized in a progressive manner to bring about changes in knowledge, skills, and attitudes.

- *Introduction to Nutrition, Agriculture, and Gardening*
- *Getting Physically Active*
- *Nutrients We Need*
- *Serving Sizes*
- *MyPlate*
- *Food Labels*
- *Consumerism*
- *Making Healthy Snacks*

- **Scaffolding**: Facilitating learners' development by building on prior knowledge to help expedite the learning of new information and skills.
- **Spiraling**: Revisiting concepts repeatedly; building and elaborating upon them progressively to achieve full understanding.

Educator Professional Development

- The perpetuation transmission teaching methods in science is largely the result of approaches to professional development used with science educators (Garet et al., 2001).
- Most professional development in science uses ***traditional*** strategies (e.g., workshops, conference presentations, institutes, and courses), episodic events that occur at a set time and location with content delivered by someone external to the educators' learning setting. and lacking sustained.
- Traditional professional development strategies lack ongoing support; shown to be ineffective in fostering meaningful change in practice (Garet et al. 2001; Loucks-Horsley et al. 2003; Penuel, Fishman, Yamaguchi, and Gallagher 2007).

Educator Professional Development

- Effective approaches to educator professional development in science are referred to as ***reform*** strategies.
- Features include: multiple increments; active learning; focus on knowledge and skills; data-driven; constructivist-based.
- **Key point:** Professional development mirrors inquiry-based experiential learning. Educators better understand the process and are more effective at implementing it.

Where to Facilitate Science Learning?

- School-based instruction (**formal** education) – need more emphasis on science and improved pedagogy.
- Out-of-School-Time (OST) Education Programs (**informal** and **nonformal**) – need systematic approaches, high quality materials, and professional development opportunities for educators.

Questions

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