Photosynthesis, Food, and Populations:
A Squared Away Unit

About the author

Formerly a fisheries biologist, James Sammons was a successful science classroom teacher for thirty years. He has been recognized by the National Science Teachers Association, the Soil Conservation Service, and the National Association of Geoscience Teachers for his ability to design and manage new and innovative field and laboratory-based investigations for middle and high school students. Today he writes extensively with his wife, Fran, for science and education and is the co-author of *Skateboard Science*.

10200 Jefferson Blvd • P.O. Box 802 Culver City, CA 90232
Phone: (800) 359-0961 • www.teachinteract.com
ISBN# 978-1-56004-595-3

Introduction to *Squared Away* Units

"Squared away" was originally a nautical term used to announce that the sails of a square-rigger sailing ship were correctly set. The navy came to use the phrase to describe sailors who completed a task with competency, as in, "He was right squared away!" We have adopted the term to describe students who demonstrate competency in specific content and skills.

Each *Squared Away* unit allows both teachers and students to concentrate on basic concepts that can be mastered in a relatively short period of time. The basic subconcepts are taught in four instructional blocks. The daily activities are interactive, exploratory, and reflective—all best practices to maximize student learning. By the end of each block, students must demonstrate mastery of the subconcepts. After completing four blocks, students may be considered Squared Away. However, to earn a Golden Square, students must go beyond the basic level indicating that they achieved an exemplary score on a final test/project or mastered a final task requiring higher-level thinking skills.

Developing student competency is the major goal of all *Squared Away* units.

Levels: The units are designed as complete, stand-alone lessons. Although written for either grades 2–4 or 5–8, the content may be used for instruction, enrichment, or remediation.

Differentiation: Teachers are encouraged to reteach and scaffold the learning so that all students master the concepts. Investigations take place in cooperative group settings that allow for peer teaching and support for students with learning difficulties. An extensive list of optional extra activities follows each Instructional Square and provides opportunities for independent or group investigations. The "Golden Square" activities offer even more challenges for your more talented students.

Student grouping: Students may work in *Squared Away* units as individuals, in pairs, or in heterogeneous teams of three or four. When working in groups, students are responsible for their own learning

From 'Photosynthesis, Food, and Populations: A Squared Away Unit'. Product code INT849.
Interact. (800) 359-0961. http://www.teachinteract.com/

and for supporting the learning of their team mates. All units provide Cooperative Group Work Rubrics.

Lessons: The lessons begin with a list of concepts to be taught, materials needed, and a lesson-plan schedule. Each lesson is divided into parts that specifically list an objective followed by the teaching plans to achieve the objective.

Assessments and rubrics: All units include a pretest/posttest to be administered before starting and after completing the unit. You also assess students daily to check mastery of content and to determine points of confusion. Part of the assessments requires students to explain orally or in writing what they understand. Students may retake assessments until they achieve mastery. The units provide quizzes, tests, and rubrics. There are many opportunities in the daily lessons, optional activities, and assessments for students to demonstrate Gardner's Multiple Intelligences.

Timeline: The lesson plans address four basic instruction blocks and one block to achieve a Golden Square. These may take five or more days depending on the instructional time available and/or your students' grade level and prior knowledge.

Table of Contents

Table of Contents

Table of Contents

General Directions

Photosynthesis, Food, and Populations

Instruction blocks

This unit is divided into four instruction blocks that address specific instructional objectives related to photosynthesis, food, and populations. Each block is sequential and builds on the knowledge and skills learned in the block before it. Always evaluate the tests of one block before going on to the next.

Student grouping

Students will work in this Squared Away in unit teams of four that sometimes break into pairs. Create your teams before the first lesson. Generally, the most successful teams are mixed in terms of gender, science sense, and study skills.

Student roles rotate after each Square test. You may combine roles when necessary. Extra team members rotate in and out of roles. (Combine Leader and Reader for teams of three.) Change roles only after each individual Square Test.

Leader: organizes the team and directs team members as needed. He/she checks that the day's assignments are complete and makes sure teammates submit all assignments. The Leader is the time keeper who also keeps the team motivated and on-task.

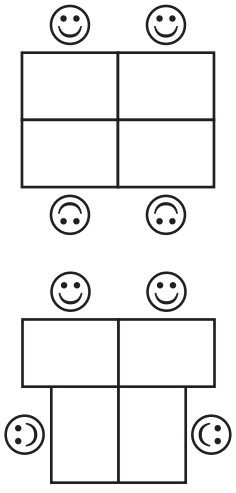
Reader: reads handouts and/or activity directions, clarifying and repeating as necessary

Writer: writes the team's responses and uses the calculator

Manager: collects and returns supplies, handouts, and materials needed for the team's daily work. The Manager maintains the team folder and hands it in to the teacher at the end of each day.

Classroom arrangement

Organize students around four desks that will serve as a table for the activities. Allow as much space as possible between groups so that students can converse among their teammates without distractions.



Supplies and duplicated materials

At the beginning of each lesson, the supplies you need to gather and the photocopies you need to prepare are listed. Most supplies can be found in your classroom. Consider photocopying all the handouts ahead of time and

Special Directions
Before Starting This Unit

1. Read through the teacher's guide to familiarize yourself with the content and materials. Read the **Author's Note** on page 16.

2. Prepare an energy coin.

   The energy coin puzzle is an easy, but unfamiliar task. Most student difficulties will stem from misreading or forgetting part of the instructions. Follow the procedure to make a successful coin beforehand so that you can anticipate where missteps are likely to occur. See page 14 for instructions.

3. Organize the teams and prepare the team folders. See pages 9–10.

4. Unit introduction and **Pretest**.

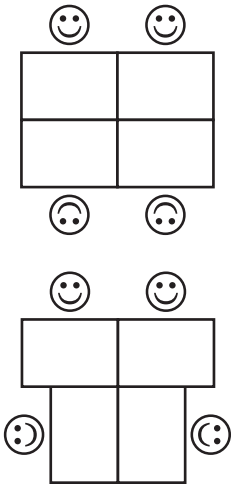
   a. Photocopy and hand out the unit's introduction. Tell students what they will be learning over the next week or so.

   b. Administer the pretest to all students individually before starting this unit. Remind students not to guess on a pretest. They can just write a "?" next to the question. Correct each answer to the student response questions using the **Concept Content Rubric's** 4-3-2-0 scoring system, where four recognizes an answer that demonstrates clear understanding, three recognizes good understanding, two recognizes some understanding, and zero recognizes little or no understanding. Having a general idea of student pre-knowledge will help you pace your instruction.

5. Photocopy the handouts and collect the materials before beginning Instruction Block One.

6. If you decide to award squares, prepare the awards background square and the colored squares. Attach them to folders. If you decide to use a chart, explain the chart when you explain the unit.

7. On the day you begin the unit, arrange the room. (See left.) Announce the teams. Assign student roles. Review the duties of each role using the **Cooperative Group Work Rubric**.



Pretest/Post Test Answer Key

1. A
2. A
3. B

4. C
5. D
6. C
7. B
8. A
9. B
10. $C_6H_{12}O_6 + 6O_2 \longleftrightarrow 6H_2O + CO_2$ **or** $6H_2O + CO_2 \longleftrightarrow C_6H_{12}O_6 + 6O_2$
11. D
12. C
13. B
14. A
15. C
16. D
17. Answers may vary, but will begin with a green plant and end with an apex predator.
18. C
19. at night
20. A
21. C
22. B
23. Leaf on bottom level, aphid on 2nd level, beetle on 3rd, robin on 4th and hawk on top level
24. C
25. D

Author's Note to the Teacher

Undoubtedly you have seen the photosynthesis-oxidation equation before, usually written like this:

$$6H_2O + CO_2 \longleftrightarrow C_6H_{12}O_6 + 6O_2$$

In this Squared Away unit the equation is reversed and written like this:

$$C_6H_{12}O_6 + 6O_2 \longleftrightarrow 6CO_2 + 6H_2O$$

Because the process is determined by the metabolic activity underway, the choice of direction is arbitrary. However, there are important instructional reasons for the direction used here. Too many students are presented with the photosynthesis equation as something to be memorized. Students will ultimately memorize the equation in this unit, too. But first they will build a simple sugar from individual atoms and then dissemble it. The inductive thinking required in the disassembly process, oxidation, is the key to mastery. In so doing, they will become well-familiar with the composition and number of compounds involved in the processes. They will discover exactly why:

- Animals need oxygen.
- Primitive metabolic systems can beat the no-oxygen condition.
- At the level of the cell, there is no practical difference between starvation and suffocation—energy becomes unavailable either way.

After attaining this deep level of understanding of oxidation, learning the photosynthesis equation becomes a simple translation.

In *Photosynthesis, Food, and Populations*, the equation is described as oxidation-photosynthesis for internal consistency. After Instruction Block Two, you may choose to show students a text or other reference that shows the equation written as photosynthesis-oxidation. Ask students to compare the reference to the equation as they know it. They should easily recognize the two as the same, but reversed, by the location of the simple sugar. You may also find a reference that refers to photosynthesis-respiration. You can have students discover that respiration in this sense is used to mean oxidation using the same comparison technique. Should you present this second comparison, point out that the use of respiration to refer to the *chemical equation* is not appropriate. Photosynthesis and respiration are correctly used as *process* labels.

Instruction Block One

Economies and the Energy Coin

Square One Concepts/Skills*—Students will understand that:*

- An economy can be based on a direct exchange or indirect exchange that uses a token or coin.
- Living creatures exchange food energy in an energy economy that is very similar to the money economy of people.
- When circumstances change, restricting an economy, all living creatures (including humans) employ different strategies to survive.
- The basic carrier of food energy is simple sugar.
- Glucose is one of several different simple sugars.
- Plants store food energy by concentrating simple sugars as starch in various parts of the plant.
- Build a simple sugar molecule, the product of photosynthesis.

Materials

- Blank paper, glue sticks, scissors, pencil with an eraser on the end, highlighter or light colored crayon

Duplicate

- Pre-post tests—*two per student*
- Cooperative Group Work Rubric—*one class copy to post and one per team folder*
- Introduction to the Squared Away unit—*one per student*
- Introduction to Photosynthesis, Food, and Populations (2 pages)—*one per student*
- Stop/Think/Draw/Write 1—*one per student*
- Making an energy coin (2 pages)—*two per team*
- Stop/Think/Draw/Write 2—*one per student*
- Exploring your energy coin—*one per student*
- Where is starch stored?—*(optional) one per student*
- Quick Team Quiz One—*one per student*
- Square One Test—*one per student*

Teaching tip

Use the **Concept Content Rubrics** or **Cooperative Group Work Rubrics** to award points to teams. Keeping track of points sometimes motivates teams to make stronger efforts.

Lesson plan schedule

- Introduction to *Squared Away*
- Introduction to Photosynthesis, Food, and Populations
- Stop/Think/Draw/Write 1
- Making an Energy Coin
- Stop/Think/Draw/Write 2
- Review of team energy coins
- Exploring Your Energy Coin
- Optional Activities
- Quick Team Quiz One
- Square One Test