

# CASE TEACHING NOTES for “Sweet Indigestion: A Directed Case Study on Carbohydrates”



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## **INTRODUCTION / BACKGROUND**

This directed case study provides students with an interesting story about carbohydrates and intestinal gas in a format that is funny, quick, and feasible for even the largest classes.

In the constructivist model of learning, the first step to successful mastery of a new topic is to figure out what you already know and then add and organize new information by building on that initial knowledge (Bransford, Brown et al, 2000). Since most Americans are familiar with the hype over low-carb diets, this case allows students to talk about their existing knowledge of carbohydrates (including misconceptions), thus providing a good launching point for learning more detailed information about carbohydrates and biochemistry.

Molecules and dieting are topics rife with misconceptions. According to a survey of 1,017 adult Americans commissioned by the Partnership for Essential Nutrition, almost 40% of adults are currently trying to lose weight, and 19% of them are specifically reducing carbohydrates to do so. This is hard to do correctly if you can neither identify a carbohydrate nor give the reason for consuming carbohydrates in your diet. For example, the adults surveyed by the Partnership for Essential Nutrition were unable to identify many carbohydrate-containing foods; only 61% of respondents could name oatmeal as a food rich in carbohydrates, 40% could name bananas, 36% apples, 20% tomatoes, 17% broccoli, and 12% named lettuce. This case helps remedy this ignorance by completing the following objectives.

### **Objectives**

In working through this case, students will:

- practice recognizing carbohydrates from a list of ingredients to identify their pre-existing knowledge and misconceptions;
- construct their own rule for determining if foods contain carbohydrates;
- practice differentiating between the different classes of carbohydrates on a food label; and
- using the fact that undigested carbohydrates cause gas, investigate carbohydrate utilization by the body and tackle the issue of whether or not eliminating carbohydrates can be healthful.

Instructors who use cases in their classes already know that students are also more motivated to learn if the new concepts are interesting and could be useful and applicable to situations in their own lives. Cases also provide opportunities for students to seek patterns of related concepts through verbal communication. However, in large classes, classroom management issues make it almost impossible to engage all students and to encourage participation over extended periods of time. There are also very few, short, self-contained cases

that can easily be adapted to a large lecture class without grading support. This case can be completed in 20 minutes, requires minimal grading, and can be used as a much-needed interactive exercise during a lecture.

I use the case in my large-enrollment, one-semester introductory biology course, which is taken primarily by sophomores to fulfill a general education requirement. The 3-credit-hour course consists of three 50-minute weekly meetings in a lecture classroom with no recitation section, although 65% of students are enrolled in an optional 1-credit-hour lab section. This case could be used in any non-majors introductory course or in a nutrition or anatomy/physiology course.

The case requires little preparation or existing knowledge from the students. I present the case at the beginning of the semester to over 300 students, just after students have received a brief introduction to biochemistry in a previous lecture. Instructors could also use this case in or around a digestion lecture.

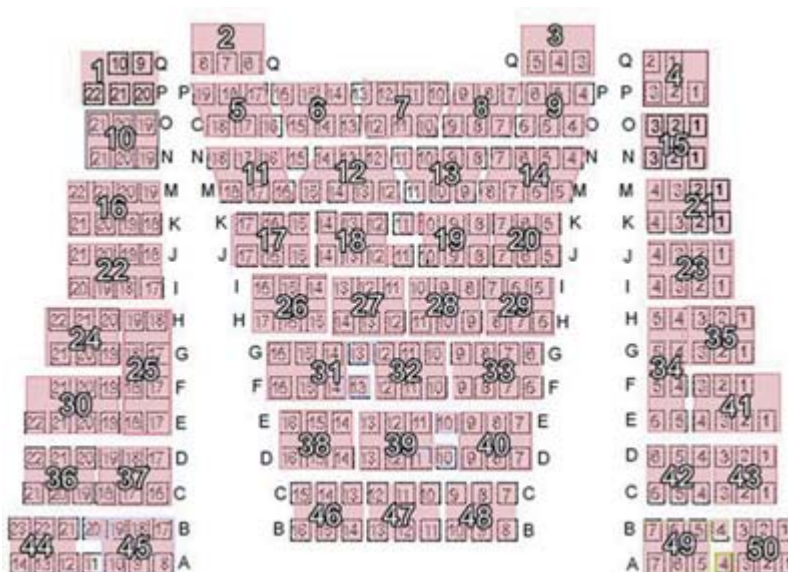
## CLASSROOM MANAGEMENT

The case takes about 15 to 20 minutes of student discussion, which I intersperse with mini-lectures lasting about 10 minutes, so that completion of the case requires a 50-minute lecture session.

Students are given access to the case before class as a PDF on the course web site, but have not been asked to answer any of the questions. They have only been required to read about the basic chemistry of macromolecules from their textbook.

### *Organizing Student Groups for Large Classes*

Students are assigned to work on the case in groups of six (see the chart below) that have been instituted at the first day of the semester using a group generation program from web-CT course management program. Each group has a seating location in the lecture hall, and they keep handouts and an attendance sheet in folders that are brought to class each day.



## **Running the Case**

I hand out Parts I and II of the case on opposite sides of a single sheet of paper at the beginning of class. After a brief introduction to the process of case-based learning, I ask the students to read Part I of the case and answer the first set of questions in their groups. After five minutes of discussion, I call on groups at random to provide answers to the questions. Usually, I call on 10 groups to answer the first question, which is designed to place students at ease and help identify student's initial knowledge as correct or otherwise. The second question provides a framework to help students place their general dietary knowledge in the context of the function of carbohydrates in organisms and often focuses on the differences between plants and animals. The students seem really interested in knowing the answer to this section. This often generates a lot of discussion about why milk has carbohydrates and what the difference is between natural foods like brown rice and purified foods like maltodextrin.

Part II is designed to let students discover what they need to learn about carbohydrates to figure out what causes gas. I cover Part II in two stages. First I ask them to read the short scenario at the beginning and then analyze the PowerBar food label for Questions 5 and 6. After five minutes, I ask several of the student groups for their answer to Question 5 and then I have them describe how they arrived at their answer. As they describe their answers, I write their comments on an overhead visualizer camera. It is often difficult to get them to express the rationale for people living without carbohydrates in Question 6. I ask if any other groups have conflicting answers and allow students to express different opinions on this issue. Students often express the importance of carbohydrates in providing energy, and I use this to enter into the discussion of Questions 7 and 8, which they tackle for five more minutes. They often are unable to categorize carbohydrates into the various groups, so at this point I transition into a mini lecture on the classes of carbohydrates, focusing on the general classes, and then specifically on the simple sugars for five to 10 minutes. I then allow them to return to Question 8 and practice what I have just covered. When we get to the last section of Question 8, I usually return to lecture to describe how disaccharides are made and hydrolyzed. I also use the last portion of my lecture to discuss why foods are digested and discuss problems of indigestion in the case of lactose intolerance and the benefits of indigestion in the case of cellulose.

## **ANSWER KEY**

Answers to the questions posed in the case study are provided in a separate answer key to the case. Those answers are password-protected. To access the answers for this case, go to [the key](#). You will be prompted for a username and password. If you have not yet registered with us, you can see whether you are eligible for an account by reviewing our [password policy](#) and then apply online or write to [answerkey@sciencecases.org](mailto:answerkey@sciencecases.org).

## **POST-CLASS ASSESSMENT**

I use the questions below to assess the effectiveness of the activity. Some I post on Web-CT as homework, while others I use on in-class multiple choice exams. I have found them to be very helpful since it is hard with very large classes to encourage the students to do an activity unless they are getting credit for it. I give credit by using this material on exams.

## Web-CT Homework Questions

### Matching

1) Match the carbohydrate with its correct class:

<i>Carbohydrates:</i>	<i>Class Choices:</i>
Glucose	Disaccharide
Sucrose	Polysaccharide
Lactose	Monosaccharide
Cellulose	
Glycogen	

2) Match the food with the carbohydrate it contains most:

<i>Foods:</i>	<i>Carbohydrate Choices:</i>
Lettuce	Glycogen
Table sugar	Sucrose
Rice	Fructose
Liver	Cellulose
Honey	Starch

3) From the following list of foods, match the food item with the largest amount of carbohydrate found in that item:

<i>Foods:</i>	<i>Carbohydrate Choices:</i>
Potatoes	Lactose
Honey	Cellulose
Table sugar	Fructose
Celery	Sucrose
Milk	Starch

### Food Label Practice:

## Label A

Nutrition Facts	
Serving Size 1 packet (28g) makes 6-8 fl oz	
Servings Per Container 10	
Amount Per Serving	
<b>Calories</b> 110	Calories from Fat 10
% Daily Value*	
<b>Total Fat</b> 1g	2%
Saturated Fat 0.5g	2%
<b>Cholesterol</b> 0mg	0%
<b>Sodium</b> 150mg	6%
<b>Total Carbohydrate</b> 24g	8%
Dietary Fiber 1g	3%
Sugars 19g	
<b>Protein</b> 2g	
<b>INGREDIENTS:</b> SUGAR, NONFAT MILK, WHEY, PARTIALLY HYDROGENATED SOYBEAN OIL, COCOA PROCESSED WITH ALKALI, MARSH-MALLOW (SUGAR, CORN SYRUP, FOOD STARCH-MODIFIED, GELATIN, SODIUM HEXAMETAPHOSPHATE, ARTIFICIAL AND NATURAL FLAVORS, BLUE 1), CORN SYRUP SOLIDS, SODIUM CASEINATE, CARBOXYMETHYLCELLULOSE, SALT, ARTIFICIAL FLAVOR.	

## Label B

Nutrition Facts	
Serving Size 24 pieces (30g)	
Servings Per Container About 9	
Amount Per Serving	
<b>Calories</b> 130	Calories from Fat 35
% Daily Value*	
<b>Total Fat</b> 4g	6%
Saturated Fat 0.5g	3%
<b>Cholesterol</b> 0mg	0%
<b>Sodium</b> 150mg	6%
<b>Total Carbohydrate</b> 23g	8%
Dietary Fiber Less than 1g	3%
Sugars 8g	
<b>Protein</b> 2g	
<b>INGREDIENTS:</b> ENRICHED FLOUR (WHEAT FLOUR, NIACIN, REDUCED IRON, THIAMINE MONONITRATE [VITAMIN B1], RIBOFLAVIN [VITAMIN B2], FOLIC ACID), SUGAR, VEGETABLE SHORTENING (PARTIALLY HYDROGENATED SOYBEAN OIL), HONEY, GRAHAM FLOUR, MALTODEXTRIN, SALT, BAKING SODA, NATURAL FLAVOR, CINNAMON, SOY LECITHIN (EMULSIFIER).	

1. Using the list of ingredients on Food Label A, can you name which ones contain simple sugars? (You don't need to place the same ingredient twice, even if it appears more than once, but make sure that you include the entire name as it appears, for example, artificial and natural flavors and not just flavors.)
2. On Food Label A, can you name which ingredients contain complex carbohydrates? (Be sure to include the entire name including everything within the commas, for example, sodium caseinate, and not just sodium.)
3. Using the list of ingredients on Food Label B, can you name which ones contain simple sugars?
4. Using the list of ingredients on Food Label B, can you name which ones contain complex carbohydrates? (Don't worry about the stuff within the parentheses, for example, use vegetable shortening and don't worry about writing soybean oil also. Make sure though that you use the entire name as written.)

#### Multiple-Choice Exam Questions

1. Which of the following would be listed as a simple sugar on a food label?
  - a. cellulose
  - b. corn bran
  - c. guar gum
  - d. honey
  - e. starch
2. All of the following would contribute to complex carbohydrates listed on a food label, EXCEPT:
  - a. enriched wheat flour
  - b. modified starch
  - c. corn flour
  - d. sugar
  - e. graham flour
3. Which of the following would contain the greatest amount of complex carbohydrates?
  - a. peanut butter
  - b. coca cola
  - c. tuna fish
  - d. corn oil
  - e. potato chips
4. Modified food-starch on a list of ingredients on a food label would be included in total calories from:
  - a. carbohydrate
  - b. simple sugars
  - c. fat
  - d. protein
  - e. fiber
5. Powdered cellulose on a list of ingredients on a food label would be included in the recommended daily allowance of \_\_\_\_\_.
  - a. saturated fat
  - b. simple sugars
  - c. unsaturated fat
  - d. protein
  - e. fiber

6. Your doctor has recommended that you increase the amount of fiber in your diet, meaning foods derived from \_\_\_\_.
- plants
  - milk
  - meat
  - eggs
  - fish
7. Which of these ingredients on a food label would contribute significant amounts of fiber to your diet?
- milk protein
  - coconut oil
  - starch
  - rice bran
  - tuna fish
8. What type of chemical reaction results in the breakdown of organic polymers (like starch) into their respective subunits?
- hydrolysis
  - condensation
  - dehydration synthesis
  - ionization
  - oxidation
9. Which of these components of the PowerBar that we looked at in class would contribute the most to intestinal gas because it is indigestible in humans?
- high-fructose corn syrup
  - milk protein isolate
  - peanut butter
  - oat bran
  - rice
10. Which of the following foods does NOT cause gas?
- sucrose
  - fructose
  - oligosaccharides raffinose and stachyose
  - insoluble fiber
  - starch
11. Which of the following macromolecules are used as food for bacteria in the large intestine, thus forming gas as a byproduct?
- carbohydrates
  - fats
  - lipids
  - nucleic acids
  - proteins

Use this label to answer the following questions:

<b>Nutrition Facts</b>		
Serving Size 2 oz (56g)		
Servings Per Container 8		
Amount Per Serving		
<b>Calories</b> 200		Calories from Fat 10
		% Daily Value*
<b>Total Fat</b> 1g		2%
Saturated Fat 0g		0%
Polyunsaturated Fat	0.5g	
Monounsaturated Fat	0g	
<b>Cholesterol</b> 0mg		0%
<b>Sodium</b> 0mg		0%
<b>Total Carbohydrate</b>	40g	14%
Dietary Fiber	2g	7%
Sugars	2g	
<b>Protein</b>	10g	
Calories per gram:		
Fat 9 • Carbohydrates 4 • Protein 4		
INGREDIENTS: DURAM WHEAT SEMOLINA, NIACIN, FERROUS SULFATE, THIAMIN MONONITRATE, RIBOFLAVIN, FOLIC ACID		

12. What percent of the carbohydrates in this food come from simple sugars?

- a. 2%
- b. 5%
- c. 10%
- d. 20%
- e. 0

13. What percent of the calories in a serving of this food come from carbohydrates?

- a. 1%
- b. 3%
- c. 24%
- d. 80%
- e. 99%

Use this label to answer the following questions:

<b>Nutrition Facts</b>		
Serving Size 8 fl oz (240ml)		
Servings Per Container 2		
Amount Per Serving		
<b>Calories</b> 150		Calories from Fat 70
		% Daily Value*
<b>Total Fat</b> 8g		12%
Saturated Fat 5g		25%
<b>Cholesterol</b> 35mg		12%
<b>Sodium</b> 125mg		5%
<b>Total Carbohydrate</b> 12g		4%
Dietary Fiber 0g		0%
Sugars 11g		
<b>Protein</b> 8g		
Calories per gram:		
Fat 9 • Carbohydrates 4 • Protein 4		
INGREDIENTS: WHOLE MILK		

14. What percent of the carbohydrates in this food come from simple sugars?

- a. 2%
- b. 52%
- c. 12%
- d. 92%
- e. 0

15. What is the simple sugar mentioned on the food label?

- a. glucose
- b. sucrose
- c. lactose
- d. maltose
- e. maltodextrin

**Note:** Answers to questions posed in the Post-Class Assessment are included in the main answer key to the case.

## References

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**Acknowledgements:** This case study was developed with support from The Pew Charitable Trusts as part of the Case Studies in Science Workshop held at the University at Buffalo, State University of New York, on May 20–24, 2002.

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Originally published 10/13/04 at [http://www.sciencecases.org/carbohydrates/carbohydrates\\_notes.asp](http://www.sciencecases.org/carbohydrates/carbohydrates_notes.asp)

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