Unit 4: Carbohydrates
Guided Notes

Objective: This lesson outline will help you synthesize and organize the information you learn in the online lesson for this unit. It will also serve as a study guide to help you complete the study questions for this week and the exams.

Part 1 - Introduction to Carbohydrates

1a. Carbohydrates are found in every food group. Sketch the MyPlate diagram in the space below, and for each food group, fill in examples of carbohydrate-rich foods.

Part 2 - Types of Carbohydrates

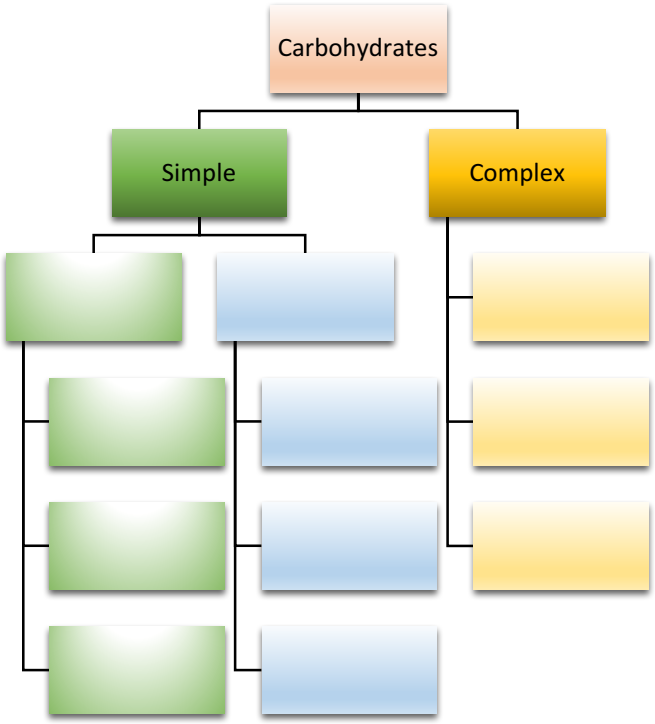
2a. When you see carbohydrates abbreviated as "CHO," what do each of those letters stand for?

C -

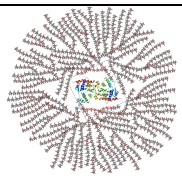
H -

O -

2b. In the diagram below, fill in the blanks for the different **types of carbohydrates**.



2c. Organize the information about **types of carbohydrates** in the table below. The first few boxes are filled in for you. Use the shapes representing the monosaccharides to draw representations of the disaccharides and polysaccharides.

Type	# of sugars	Name	Draw it!	Food Sources	Questions/Notes
Monosaccharides (simple carbohydrates)	**1**	**Glucose**		Fruit, veg, honey, corn syrup	*Why is glucose important to plants?* *To humans?*
		Fructose			*Why is fructose important to plants?*
		Galactose			*Is galactose usually found on its own in food?*
Disaccharides (simple carbohydrates)		**Maltose**			*Why is maltose found in sprouted grains?*
		Sucrose			*Is the sucrose in a sweet potato and in table sugar chemically the same?* *What is the advantage of the sucrose in the sweet potato?*
		Lactose			*How are the food sources for lactose different from food sources for other carbohydrates?*
Polysaccharides (complex carbohydrates)		**Starch**			*2 types of starch:* *Why is it important to plants?* *To humans?*
		Glycogen		No food sources. *Why don't we find glycogen in meat?*	*Why is it important to humans?* *Why is it branching?* *Where is it stored?*
		Fiber			*Why is it important to plants?* *What is cellulose made of?* *Do we enzymatically digest fiber?*

Part 3 - Carbohydrate Food Sources and Guidelines for Intake

3a. List the **type(s) of carbohydrates you find in each of the following food groups**. The first line is completed for you.

Food Group	Category	Types of carbohydrates (ex. glucose, fructose, starch)
Fruits	Whole	*sucrose, glucose, fructose, fiber*
	Juices	
Vegetables	Non-starchy	
	Starchy	
Grains	Non-sprouted	
	Sprouted	
Dairy		
Protein	Meat	
	Beans and nuts	
Fats		

3b. If you were trying to eliminate carbohydrates, what foods would mostly be on your plate?

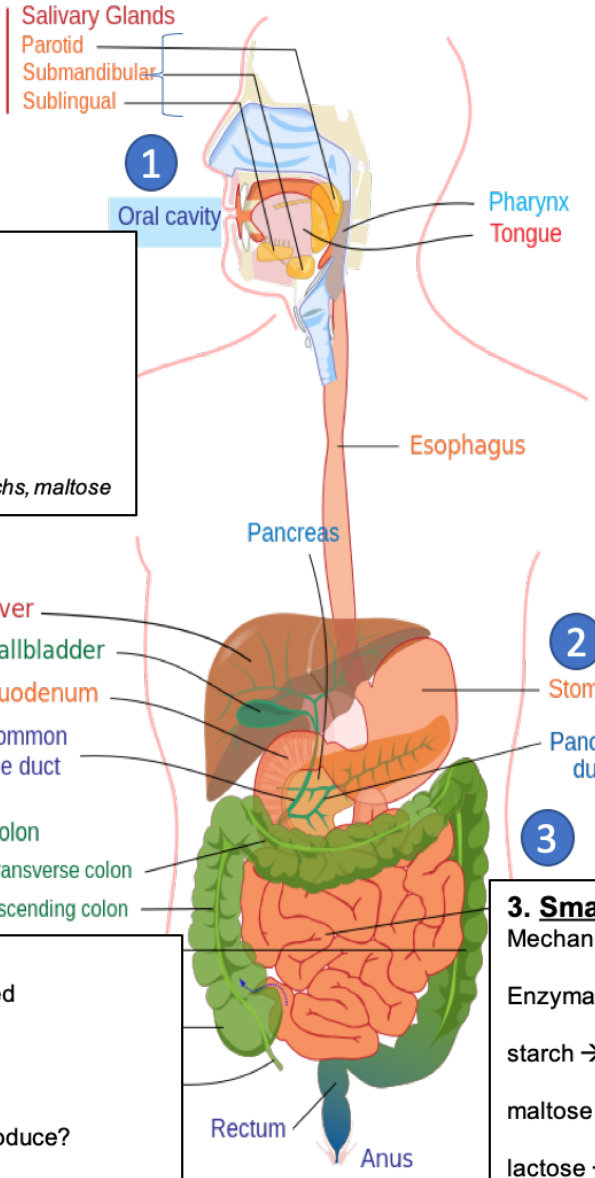
Carbohydrate Guidelines for Intake

3c. Fill in the table below on dietary recommendations for carbohydrates.

Type of guideline	Recommendation	Notes
RDA for total CHO		This is the minimum amount of glucose utilized by the _____.
AMDR for total CHO		*Which is higher, the RDA or AMDR?*
AI for fiber		Most people in the U.S. get about _____ of the amount of fiber they need in a day.
Added sugar (DGA)		On a 2,000 Calorie diet, this equals _____ tsp/day. A12 oz can of soda has about ____ teaspoons of sugar.

Part 4- Digestion and Absorption of Carbohydrates

4a. Add arrows to the diagram below to **trace the path of food through the GI tract.**
4b. Fill in the details of **what happens in each organ** in the space provided. For each enzymatic reaction, write the starting molecule, the products, and the enzyme responsible, as shown for starch in the mouth.



Mouth:
Mechanical:

Enzymatic:

salivary amylase
starch → shorter polysacchs, maltose

2. Stomach:
Mechanical:

Enzymatic:

3. Small intestine:
Mechanical:

Enzymatic:

starch →

maltose →

lactose →

sucrose →

What happens to monosaccharides in the small intestine?

What happens to fructose and galactose in the liver?

3. Large intestine:
What happens to undigested carbohydrates here?

What does fermentation produce?

1.

2.

A diet high in _____ food sources of fiber helps to maintain a healthy gut microbial population.

4c. Summary of Carbohydrate Digestion

1. What is the primary goal of carbohydrate digestion?

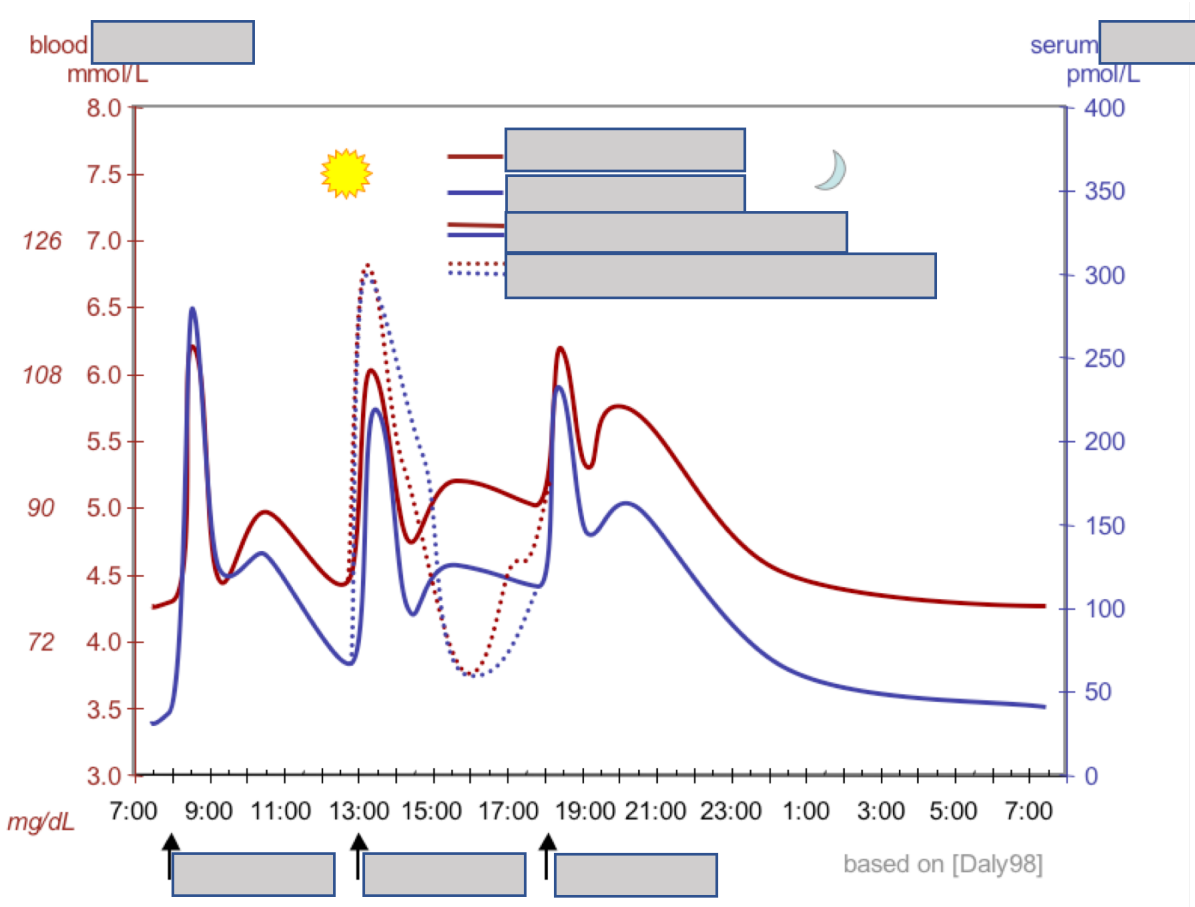
2. What happens to the following types of carbohydrates during digestion?
    a. Monosaccharides →
    b. Disaccharides →
    c. Starch →
    d. Fiber →

Part 5 - Glucose Regulation and Utilization in the Body

5a. Define the following terms:

- Homeostasis
- Hypoglycemia
- Hyperglycemia
- Insulin
    - Where is it made?
    - When is it released?
    - What does it do?
- Glucagon
    - Where is it made?
    - When is it released?
    - What does it do?

5b. Pattern of blood glucose and insulin during the day. Label the figure by filling in the grey boxes. (If your figure is black and white, consider using colored pencils or markers to differentiate the colors of the lines.) Then answer the questions below.



- After you eat a meal, your blood glucose _____.
- In response, your pancreas releases _____.
- That hormone helps bring your blood glucose back _____.
- Which lunchtime meal would you expect to cause the biggest glucose spike?
    - Spaghetti and meatballs OR a chicken caesar salad?

5c. Fill in the blanks below on **regulation of blood glucose**.

- Insulin triggers the opening of glucose _____ on the surface of the cell, allowing glucose to enter the cell and at the same time _____ blood glucose.

- Once glucose enters the cell, how it is used depends on that cell's needs.
    - If the cell needs energy right away, what happens?
    - If the cell doesn't need energy right away, what happens?
- When blood glucose falls, several things happen to restore _____.
    - Your brain tells you to _____.
    - The pancreas releases _____ into the blood. It stimulates the _____, releasing _____ into the blood.
    - Glucagon also stimulates _____, in which new glucose is make from _____ _____. This also contributes to raising blood glucose.

5d. Fill in the blanks below on **how glucose provides energy**.

1. Glucose, a 6-carbon molecule, is broken down to two 3-carbon molecules called _____ through a process called _____.
2. Pyruvate enters a mitochondrion of the cell, where it is converted to a molecule called _____ CoA.
3. Acetyl CoA goes through a series of reactions called the _____ cycle. This cycle requires _____ and produces carbon dioxide. It also produces several important high energy electron carriers called NADH2 and FADH2.
4. These high energy electron carriers go through the electron transport chain to produce _____ -- energy for the cell!

5e. Fill in the blanks and answer the questions below on **what happens when there isn't enough glucose**.

A limited carbohydrate supply might happen if a person is _____ or consuming a very low _____ diet. In this case, your glycogen supplies will become depleted. How will you get enough glucose (especially for the brain) and energy? You'll have to use the other two macronutrients in the following ways:

_____ -- You'll continue to use some amino acids to make glucose through gluconeogenesis and others as a source of energy through acetyl CoA. However, if a person is starving, they also won't have extra dietary protein. Therefore, they start breaking down body proteins, which will cause muscle wasting.

_____ -- You can break down fat as a source of energy, but you can't use it to make glucose. Fatty acids can be broken down to acetyl CoA in the liver, but acetyl CoA can't be converted to pyruvate and go through gluconeogenesis. It can go through the Krebs cycle to produce ATP, but if carbohydrate is limited, the Krebs cycle gets overwhelmed. In this case, acetyl CoA is converted to compounds called _____ or ketone bodies. These can then be exported to other cells in the body, especially brain and muscle cells.

1. How do ketones help to preserve the protein in the muscle?

2. What is ketosis?

3. What are the symptoms of ketosis?

4. What is ketoacidosis? Who is at risk?

5. What are some drawbacks to the ketogenic diet?

Diabetes

5f. Answer the questions below about **diabetes**.

1. What is diabetes?

2. What are the 3 types of diabetes?

3. In type 1 diabetes…
    a. What is the primary problem?

    b. What are the symptoms?

    c. How is it treated?

    d. In what age group is it most commonly diagnosed?

    e. What percentage of diabetes cases are Type 1?

4. In type 2 diabetes….
    a. What is the primary problem?

    b. What is prediabetes?

    c. How many people in the U.S. have diabetes or prediabetes?

    d. People of all shapes and sizes can get type 2 diabetes, but it is strongly associated with _____.

    e. What problems can type 2 diabetes cause in the body?

    f. In the study called the "Diabetes Prevention Program," discussed in the Weight of the Nation video clip, which was more powerful in preventing diabetes, medication or lifestyle factors?

    g. Why are rates of diabetes now exploding world-wide?

5. In gestational diabetes….
    a. When does it develop?

    b. How common is it?

    c. What are some of the problems it can cause?

6. Diabetes management and prevention
    a. _____ helps to improve your body's response to insulin and can also help maintain a healthy weight.
    b. _____ well with diabetes doesn't require a special diet but instead regular, _____ meals following the Dietary Guidelines. It isn't necessary to eliminate carbohydrates or eat a low-carbohydrate diet, but emphasizing _____ food sources of carbohydrate helps with blood glucose regulation.
    c. Managing _____ levels and getting enough _____ can also help with blood glucose regulation.
    d. _____ may be needed. Insulin is needed for type 1 diabetes and may be needed for more advanced or severe cases of type 2 or gestational diabetes. Other medications can also help.

Part 6- Fiber: Types, Food Sources, Health Benefits, and Whole vs. Refined Grains

6a. Answer the following questions about **fiber**.

1. What is fiber?

2. Why is fiber important to plants?

3. Cellulose is one type of fiber. What is it made of?

4. Is fiber enzymatically digested?

5. Compare soluble and insoluble fiber in the table below.

	Soluble	**Insoluble**
Does it dissolve in water?		
Is it viscous?		
How does it affect digestion and absorption?		
What are some types?		
What are some food sources?		

6. Fiber is found in what types of foods?

7. When foods are refined, what happens to fiber (and some other nutrients)? Give an example.

8. Looking at Table 6.1, which foods have some of the highest fiber levels?

6b. Describe the **health benefits** of dietary fiber by filling in the blanks below.
A high-fiber diet has many benefits, which include:

a. Helps prevent _____. Many fibers (but mostly _____ fibers).

b. Helps maintain _____ and _____ health.

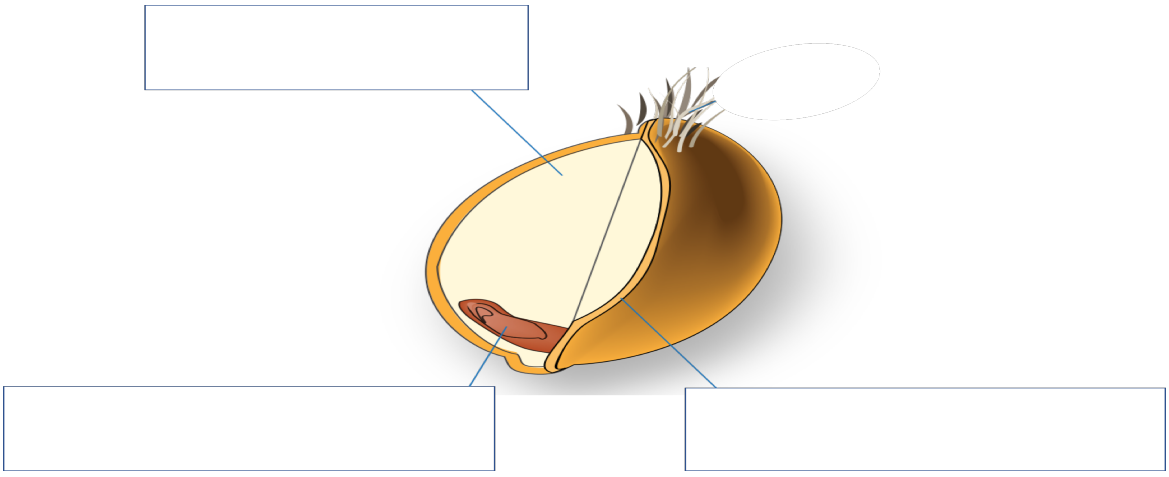
c. _____ risk of cardiovascular disease. Higher fiber intake has been shown to improve blood lipids by reducing total cholesterol, triglycerides, and low density cholesterol ("bad cholesterol," associated with a higher risk of cardiovascular disease), and increasing high density cholesterol ("good cholesterol," associated with lower risk of cardiovascular disease).

d. Lowers risk of _____. Higher fiber intake (especially viscous, or soluble fibers) has been shown to slow down _____ digestion and absorption, benefiting glucose metabolism.

e. Lowers risk of _____ cancer.

f. Helps maintain a healthy body _____.

6c. Label the grain diagram (include the name of the part and the nutrients it contains) and answer the questions about **whole vs. refined grains** below.



1. How do the DGA define whole grains?

2. What are some examples of food sources of whole grains?

3. What are refined grains? What parts of the grain are removed?

4. What are some examples of food sources of refined grains?

5. What does it mean if a refined grain is enriched?

6. Is an enriched refined grain nutritionally equivalent to a whole grain? Why or why not?

7. What is the MyPlate recommendation about whole grains?

8. How can you identify whole grains when grocery shopping?

Part 7- Sugar: Food Sources, Health Implications, Intakes, and Label-Reading to Identify Sugar

7a. Fill in the table below to compare naturally-occurring and added sugars

	Naturally-occurring sugars	**Added sugars**
Examples of food sources		(Nearly _____% of packaged foods in the U.S. are now sweetened.)
Nutritional value of the food "package"		
Example:	Sugar and food package of **apple**:	Sugar and food package of **soda**:

7b. Answer the questions below about **added sugar**.

1. On average, how much added sugar do Americans consume?

2. Are most Americans meeting the recommendation for added sugar intake?

3. What are the biggest sources of added sugars in the American diet?

4. A teaspoon is equal to _____ grams of sugar or ____ sugar cube.

5. Why might it be hard to track your added sugar intake?

6. List some of the benefits of eating less added sugar.

7. Does just eating sugar contribute to cavities or do other carbohydrates pose a problem too?

8. What do high fructose corn syrup, honey, agave syrup, and table sugar all have in common?

9. Why might it be a good idea to limit high fructose corn syrup?

10. Why might honey be a better choice than high fructose corn syrup?

11. The Nutrition Facts list sugar but it do not always distinguish between naturally-occurring sugar and _____ sugar. (This is changing with the new Nutrition Facts labels, being phased in this year.)

12. If added sugars aren't listed on the Nutrition Facts panel, where should you look to figure out if a product contains added sugar?

Part 8- Sugar Substitutes

8a. Answer the questions below about **sugar substitutes**.

1. What are sugar substitutes?

2. Give some examples:

3. Are sugar substitutes more or less sweet than sucrose?

4. What are sugar alcohols? How are they different from the other sugar substitutes?

5. Give some examples of sugar alcohols:

6. What are some side effects of consuming too much sugar alcohols?

7. Can sugar substitutes help with weight loss?
    a. In the short-term?

    b. In the long-term?

    c. What are some possible drawbacks to using sugar substitutes? What might be a better strategy?

8. Are high-intensity sweeteners safe?
    a. Is there evidence they cause cancer?

    b. What are emerging safety concerns?

9. Are natural sweeteners better than artificial ones?
    a. Does natural equate to safe?

    b. Do natural sweeteners have any drawbacks?

10. Summarize what you've learned about sugar substitutes.