METABOLIC DISEASE
# Metabolic Disease Student Workbook

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Welcome to the Metabolic Disease Module!

This module has a simple goal – to bring real world science into the classroom! We will learn about biology in a framework that is relevant to our everyday lives. The study of metabolic disease provides this framework because it focuses on how our body responds to food, and how our lifestyle choices change our health.

The Metabolic Disease Module has five units, each of which builds upon the others that came before it. The goal of each unit is to answer a new question about food use, and what this means for our health.

- **Unit 1**: What’s in your food?
- **Unit 2**: How does your body use food?
- **Unit 3**: What is metabolic disease?
- **Unit 4**: How do I identify ‘good’ and ‘bad’ food?
- **Unit 5**: How does this knowledge apply to me?
Unit 1: Where are we heading?

Unit 1: What’s in your food?
Unit 2: How does your body use food?
Unit 3: What is metabolic disease?
Unit 4: How do I identify ‘good’ and ‘bad’ food?
Unit 5: How does this knowledge apply to me?

In this unit we will begin to understand what food is, and what happens to food before it lands on our plates. We will begin the unit by examining the industrial food chain and learning about the additives in food and what they’re for – are additives necessarily bad? We will then investigate the concept of nutritive value and the different components of food and what they’re for.
Lesson 1.1 Workbook

What does 'food' mean?

We all have some idea of what food is, and we all have opinions about 'good' food and 'bad' food. But where do these opinions come from and are they justified by evidence? In this module we will look at how our perceptions of food can be manipulated by the media, and begin to explore the questions: What is food, and what makes food healthy? We will look more closely at the actual constituents of processed and unprocessed foods, and explore which of them actually impact our health. At the end of this module you will be able to evaluate nutritional claims and make your own choices about what foods are good or bad.

What is food?

In our lifetimes we will eat about 60 tons of food served at 70,000 meals and countless snacks. We are hard wired to eat when we are hungry, but have also developed the need to eat when we are bored, sitting in front of a television or gathering in social situations. Eating has become so intertwined with culture that when we think about other regions of the globe, one of the first things that comes to mind is 'what is the food like?' At first glance, defining food may seem straightforward, but what we consider food could be taboo to others, and some may say that we eat things that are not food!

Does being edible make something food?

Is a medication food? We can ingest many things but is there a difference between being edible and being food? Typically, food is considered something we eat that provides us with energy and nutrients. Energy from food is used to complete all bodily functions, from maintaining cellular structures to running and reading like you are doing now. Nutrients are substances that are essential to our health that our...
bodies cannot sufficiently make on its own. To be considered an essential nutrient a substance must have these characteristics:

- It must have a specific biological function (ex: dietary iron is used to carry oxygen on red blood cells)
- Removing it from the diet would lead to a decline in biological function (ex: iron-deficient anemia, or the lack of red blood cell function)
- Replacing that nutrient before permanent damage occurs must be able to restore that normal biological function (ex: The cure for iron-deficient anemia? Eat iron!)

If we use this set of criteria we can define six classes of essential nutrients that we obtain from eating food: carbohydrates, lipids, proteins, vitamins, minerals and water. Later in this module we will examine each of these essential nutrients in more detail. You may already be able to list some food sources rich in these nutrients, in this course we will also explore the functions of nutrients in the body and how much of each nutrient you need to keep your body running smoothly. In addition to maintaining specific biological functions, eating food also provides us with another important thing: energy. For example, carbohydrates, lipids and proteins from food are used to deliver energy to our cells. This energy is commonly called calories. Everybody has a minimal number of calories they need to eat to maintain their health, depending on their age, gender, height, weight and physical activity. Without food to supply calories to us, cells inside of your body can no longer function, and organ systems begin to shut down. We will learn more about what happens inside of your body in periods of prolonged fasting, as well as feasting, later in the module.

Food is more than a set of essential nutrients

If there were a food product that contained the perfect amount of each nutrient, would you want to eat it three meals a day? Many science fiction novels and films have imagined a future where this is true: humans would no longer “waste” their time growing, preparing and eating meals. But in saving this time what sort of customs or traditions would be lost?

Think about your favorite foods, and ask yourself: Why is this food so good? Is it the flavors, the smells, or the look of the food? Or do you associate a good memory with eating that food? Everybody has their own personal connection to food, a connection that shapes the flavors that we like or dislike.

1. Essential nutrients are:
   a. In everything edible.
   b. Needed by the body and made by the body.
   c. Needed by the body and must be eaten.
   d. All of the above.

2. The number of calories in food tells us:
   a. The amount of fat in food.
   b. The amount of energy in food.
   c. How much you can eat.
   d. If the food is healthy.
How does food get to our table?

The agricultural industry in America

Farming and the cultivation of crops allowed our early ancestors to give up their nomadic lifestyle and begin settling in villages. Up until the early 20th century, most farms were family owned and operated, and were much smaller than they are today. Food sheds, or regional food systems, were also much smaller. For example, if you lived in New England during this time, you would rarely, if ever, find fresh citrus on your table because it does not grow that far north. Instead, you would rely on crops that were being grown in your local area to provide you with all of your nutrients.

One of the impacts of the Second World War was a change in the food system in America that led to the national and international food exchange that we have today. Many technologies that were developed for the war effort began to trickle into the agricultural industry. For example, DDT is a chemical that was used to prevent the spread of infectious diseases like malaria and typhus by killing insect vectors like mosquitoes and fleas. A major limitation in farming is insect damage to crops, which limits food output and contributes to food shortages. After the war, farmers began using DDT on their crops as a pesticide to kill the crop damaging insects.

Industrial farming equipment also became more commonplace after the war, and small farms were able to use tractors to increase their food yield while employing fewer farm workers. Since then, the number of farms in America has dropped remarkably, and it is increasingly difficult to find true family farms that are not run by a large corporation.

Major upsides of industrialized food

The industrialization of agriculture in the United States has led to increased product yield, which in turn keeps the price of food relatively low to consumers. For example, from 1970 to 1995 the yield of wheat and rice nearly doubled, and most industrial countries achieved sustained food surpluses for the first time.
4. Which is true of our food system today?
   a. We have a primarily local food shed.
   b. We can always tell where our food is from.
   c. The food in the grocery store is from all corners of the world.

5. Food processing:
   a. Increases food shelf life.
   b. Decreases food waste.
   c. Prevents food shortages.
   d. All of the above.

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**LESSON READINGS**

rather than going through periods of famine. However these measures come with negative consequences, including breaches in food safety and devastating environmental impacts.

We no longer have a regional food system, as food is shipped from all corners of the globe. To witness this, take a walk through the produce section of the grocery store and read where the fruits and vegetables are coming from. There’s a good chance that your fruits and vegetables are coming from parts of the world that you will never personally travel to. This global approach to food supply allows us to have fresh produce year round, but it increases greenhouse gases from transporting the food, and may decrease the **nutritive value** of the foods that we eat.

**Food processing, for better or worse**

While we may think of processed foods as a relatively new invention, evidence of preserving foods through drying, fermentation, cooking or curing with salt exists in Greek, Egyptian and Roman writings. Today’s processed foods are undoubtedly different than our ancestors’, although we still use some of the same methods for food preservation. Like the changes made to growing food discussed above, many of the modern food processing technologies were developed to serve military needs. The process of canning food derived from a vacuum bottling technique developed in 1809 to preserve food shipped long distances to French troops. Later, Louis Pasteur proved that heat killed bacteria, and in 1862 pasteurization was discovered, establishing a protocol in which food could be made microbiologically safe for storage, a process still used today for canned foods.

In the 20th century, both World War II and the space race contributed technologies that were adapted to food processing. Advances such as juice concentrates, freeze-drying, and the introduction of artificial sweeteners, coloring agents, and preservatives increased the shelf life and diversity of foods that could be processed. Indeed, this processing reduces food waste by preventing spoilage and making foods more suitable for transport around the globe.

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**DEFINITIONS OF TERMS**

**Nutritive value** — A measure of the contribution of a food to the overall nutrient content of a diet. Foods with a lot of vitamins and minerals will have a higher nutritive value.

For a complete list of defined terms, see the **Glossary**.
LESSON READINGS

In Western Europe and North America, the second half of the 20th century gave rise to convenience foods. Food processing companies targeted their products towards middle-class working wives and mothers like in the advertisement on the previous page (Figure 4). Frozen foods and TV dinners were sold as ‘time savers’. This era of quick and easy foods is still where we find ourselves today.

In modern times, the process of getting food to the table is so complex that we sometimes question whether we can still call some of these products “food”. Nonetheless, food processing has advantages. Vitamins and minerals are often added to certain food products to increase their nutritive value, bringing these essential nutrients to populations without year-round access to fresh fruits and vegetables.

In the next two lessons we will learn more about items that are added to food intentionally or unintentionally. Chemicals called additives are added to food to improve taste, nutritional quality or shelf life. Because food processing typically uses large mixing, grinding, chopping and emulsifying equipment, other chemicals or microbes can inadvertently get into the food, called contaminants.

Striking a balance: Why is our diet important?

The types of nutrients that we consume can have a lasting effect on our health. Even more, food impacts health not only through what we eat, but also how much we eat. Both the under consumption and overconsumption of food can lead to negative health outcomes. In developed countries like the United States, calorie rich food is abundant and relatively cheap, so it makes it easy to over-consume food. Because of this, the U.S. has led the globe in rates of people that are either overweight or obese.

Micronutrient deficiencies

Micronutrient deficiencies arise from eating too little of a particular vitamin or mineral. Some common micronutrient deficiencies in the United States include iron, calcium, vitamin B12 (especially in people who are vegetarian or vegan) and iodine. Your risk for having a particular micronutrient deficiency depends
upon your age, gender, and your access to fresh healthy foods. Around the world micronutrient deficiencies are associated with poverty and insufficient intake of a balanced diet, and we often imagine a person that is starving when we think of someone with a micronutrient deficiency. A new trend is emerging however, in which people who are overweight or obese also have one or more micronutrient deficiencies. Consuming a diet high in calories, but low in nutritive value, causes this new phenomenon.

Metabolic Syndrome

With the rise of obesity in the U.S., there has been a subsequent rise of people going to their doctors with a common set of symptoms that have been lumped together and called Syndrome X, or Metabolic Syndrome. There are five classic symptoms or signs of Metabolic Syndrome that physicians will use for diagnosis:

- Large waist circumference, demonstrating central obesity – Carrying a lot of weight in the middle portion of your body is associated with poor health outcomes. This body type is often called ‘apple-shaped’ shown to the right.

- Elevated blood pressure, also called hypertension – Increased blood pressure is the result of the heart or kidneys not properly functioning.

- High blood triglyceride concentrations – A measure of how much fat is in the blood. A diet high in fat or sugar can lead to increased triglyceride concentrations.

- Low blood HDL (‘good’) cholesterol concentrations – HDL cholesterol is responsible for removing extra fat from the tissues, so low levels are indicative of an excess of fat in the tissues and blood.

- High fasting blood glucose concentration, also called insulin resistance – The liver and the pancreas tightly regulates blood glucose (or sugar in the blood) concentrations. In type 2 diabetes the pancreas no longer functions normally and fasting blood glucose levels rise.

While these symptoms are characteristic of Metabolic Syndrome, obesity is closely linked to other diseases like heart disease and type 2 diabetes, both of which are chronic diseases requiring long-term use of prescription drugs and lifestyle changes to overcome. Unfortunately these diseases used to be only diagnosed in older adults, but because obesity is affecting younger populations there is a rise in early onset of heart disease and type 2 diabetes. We will learn more about these metabolic diseases in greater detail in Unit 3.
Give a brief argument both for and against the statement “a candy bar should be considered food”.

__________________________________________________________________________________________________________________________________________________________
## TERMS

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calorie</td>
<td>A unit of heat energy. 1 Calorie = 1,000 calories = 1 kilocalorie.</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>A large group of compounds occurring in foods, including sugars, starches and fiber. Found in grains, produce, desserts and sweet beverages.</td>
</tr>
<tr>
<td>Fasting</td>
<td>A period of time when no food is consumed.</td>
</tr>
<tr>
<td>Feasting</td>
<td>A period of time when food is consumed, such as during a meal.</td>
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<tr>
<td>Food Additive</td>
<td>A chemical, or chemicals, added to food to improve its flavor, appearance or shelf life.</td>
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<tr>
<td>Food Contaminant</td>
<td>Harmful chemicals or microorganisms that unintentionally occur in food from growing or processing.</td>
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<tr>
<td>Food Shed</td>
<td>An area of land including where food is produced, transported to, and consumed.</td>
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<tr>
<td>HDL</td>
<td>A type of lipid-carrying protein in the blood that protects against cardiovascular disease by removing cholesterol from arteries or tissues.</td>
</tr>
<tr>
<td>Lipids</td>
<td>A class of compounds called fatty acids, including oils and solid fats.</td>
</tr>
<tr>
<td>Metabolic Syndrome</td>
<td>A combination of medical disorders that, when occurring together, increases the risk of developing cardiovascular disease and diabetes.</td>
</tr>
<tr>
<td>Minerals</td>
<td>Basic elements that are required for biological reactions.</td>
</tr>
<tr>
<td>Nutrient</td>
<td>A substance in food that provides nourishment for growth and maintenance of essential biological functions.</td>
</tr>
<tr>
<td>Nutritive Value</td>
<td>A measure of the contribution of a food to the overall nutrient content of a diet. Foods with a lot of vitamins and minerals will have a higher nutritive value.</td>
</tr>
<tr>
<td>Pesticide</td>
<td>A substance used to destroy insects harmful to crops.</td>
</tr>
<tr>
<td>Proteins</td>
<td>A class of compounds consisting of one or more amino acid. Found in legumes, meats and eggs.</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>The main constituent of natural fats and oils. High levels in the blood indicate a high risk for cardiovascular disease.</td>
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### TERMS

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<tr>
<th>TERM</th>
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<tbody>
<tr>
<td>Vector</td>
<td>An organism that transmits a disease or parasite from one animal or plant to another.</td>
</tr>
<tr>
<td>Vitamins</td>
<td>Compounds that cannot be synthesized by the body but are required for biological reactions.</td>
</tr>
</tbody>
</table>

For a complete list of defined terms, see the [Glossary](#).

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**Workbook**

*Lesson 1.1*