

Cross-Curricular Discussion

After students have had a chance to review the article "[Data back ban of artificial trans fats](#)," lead a classroom discussion based on the questions that follow. You can copy and paste only the questions that apply to your classroom into a different document for your students.

Chemical and Physical Sciences

Discussion Questions:

- 1. Describe the chemical structure and general properties of lipids.** *[Lipid molecules include fatty acids, triglycerides, cholesterol and other molecules. They all contain a long hydrocarbon chain: a "tail" containing many carbons (C) and hydrogens (H), and a carboxylic acid "head" made of a carbon double-bonded to an oxygen and single-bonded to a hydroxyl group. Given this chemical structure, lipids don't typically have much electrical charge or electrical polarity, whereas water molecules (H₂O) are very polar (partially negative oxygen and partially positive hydrogens). Because the nonpolar tail is much longer than the polar head, lipids are hydrophobic and act as effective barriers to more polar molecules. Lipids will float on the top of water, form clumps in water and do not dissolve in water. That's why you have to use soap (another lipid) to get rid of greasy residue, instead of simply rinsing with water. Lipids are important in biology and form the outer membranes of cells. Lipids in soap and in cell membranes have charged phosphates connected to one end, so they have intermolecular attraction to water molecules.]*
- 2. What is the chemical difference between saturated and unsaturated fatty acids? What does monounsaturated versus polyunsaturated mean?** *[Saturated fatty acids are saturated with as many hydrogens as their carbon backbones can hold; the carbons just have single bonds between each other. Unsaturated fatty acids have fewer hydrogens bonded to the carbon backbone, because some of the carbons have double or even triple bonds between them. Monounsaturated fats contain only one double bond in the carbon chain, and polyunsaturated fats contain more than one double bond.]*
- 3. Are trans fats saturated or unsaturated fatty acids, and where do they come from in foods?** *[Trans fats are a type, or one isomer, of unsaturated fatty acid. Most natural unsaturated fats in foods are in the cis form, as opposed to the trans form (though natural trans fats do exist). Trans fats in food generally come from artificially produced partially hydrogenated vegetable oils that are used in cooking, especially for fast food.]*

Extension Prompts:

- 4. What are isomers? Explain the difference between cis and trans isomers.** *[Isomers are two or more molecules with the same chemical formula but a different arrangement of atoms (either by structural connectivity or spatial arrangement). Cis and trans isomers create different spatial arrangements of atoms.]*

In the cis conformation, the hydrogens bonded to the two double-bonded carbons are on the same side of the double bond, which bend the carbon chain segments on either side of the double bond toward each other, creating a “kink” in the molecule. In the trans conformation, the hydrogens bonded to the two double-bonded carbons are on either side of the double bond from each other. In this conformation, the two parts of the carbon chain go away from one another, creating a long, linear molecule. If a molecule kit is available to build the structures illustrating the different structures of trans and cis unsaturated fats, then have groups of students build the molecules.]

- 5. Saturated fats and trans fats tend to have a higher melting point than unsaturated fats. Explain the difference in their physical properties based on their differences in molecular structure.** *[Generally, the greater the saturation, the lower the melting point. But a molecule in the trans conformation will have a higher melting point than a molecule with the same number of double bonds in the cis conformation. Saturated fats and trans unsaturated fats are more dense than cis unsaturated fats, because the molecules of cis unsaturated fats tend to be less linear in nature and don’t stack together as well.]*
- 6. What is the hydrogenation process, and what does it have to do with trans fats?** *[Many trans fats are added to food because the foods are prepared with partially hydrogenated vegetable oil. The hydrogenation process forces hydrogens to saturate double bonds. Partial hydrogenation generally yields the trans molecular configuration, which raises the fat’s melting point and flash point. These “new” fats can serve different purposes such as long-lasting oils for frying or butter substitutes such as margarine.]*

Chemical and Physical Sciences Question Bank

Describe the chemical structure and general properties of lipids.

What is the chemical difference between saturated and unsaturated fatty acids? What does monounsaturated versus polyunsaturated mean?

Are trans fats saturated or unsaturated fatty acids, and where do they come from in foods?

What are isomers? Explain the difference between cis and trans isomers.

Saturated fats and trans fats tend to have a higher melting point than unsaturated fats. Explain the difference in their physical properties based on their differences in molecular structure.

What is the hydrogenation process, and what does it have to do with trans fats?

Biological Sciences

Discussion Questions:

- 1. How are fats metabolized when you eat them, and what are the main purposes they serve in the body?** *[Enzymes called lipases break down fatty acids and other lipids into small pieces. Those pieces can be broken down all the way to produce energy in the mitochondria of cells, or used by cells to build up new lipid molecules. Lipids also provide insulation for the skin and around certain organs and act as an energy reserve.]*

2. **How are trans fats metabolized differently than natural fats?** *[This is still a subject of scientific research. There are many types of enzymes called lipases involved in breaking down fats, and it appears that they respond differently to the types of bonds that are in trans fats vs. regular fats. This could have to do with the fact that both saturated and cis-unsaturated fats are naturally produced. Our bodies have the enzymes required to break down the natural fats, but it is not clear if these enzymes work as well on trans fats that are synthetically produced.]*

Extension Prompts:

3. **What causes atherosclerosis? How does atherosclerosis relate to heart attacks and stroke? What roles do macrophages, high-density lipoproteins and low-density lipoproteins play in atherosclerosis?** *[Atherosclerosis is the buildup over time of plaque in arteries, constricting the flow of blood and potentially causing heart attacks (if enough oxygen-carrying blood cannot get to the heart muscle) and strokes (if enough blood can no longer get to areas of the brain). Low-density lipoprotein, or LDL, is blood protein carrying lots of lipids such as fats and cholesterol. High-density lipoprotein, or HDL, is blood protein not carrying many lipids; it is called high-density because protein is more dense than in LDLs. In small amounts, LDL provides useful supplies of lipids for cells, but in large amounts it causes problems. Macrophage cells are the “goats” of the body, wandering around eating garbage to help clean up. If macrophages consume too much LDL, they cannot digest it and get very sluggish and “sick.” The “sick” macrophages accumulate on the walls of arteries, and over time they form a plaque.]*

Biological Sciences Question Bank

How are fats metabolized when you eat them, and what are the main purposes they serve in the body?

How are trans fats metabolized differently than natural fats?

What causes atherosclerosis? How does atherosclerosis relate to heart attacks and stroke?

What roles do macrophages, high-density lipoproteins and low-density lipoproteins play in atherosclerosis?

Experimental Design and Public Policy

Discussion Questions:

1. **After thinking about the general design of the study and answering the article-based observation questions, what changes to the study design might show even better evidence linking trans fats regulation policies to cardiovascular disease risk?** *[Larger populations in areas with and without trans fats, longer periods of time from areas with the ban, measuring or minimizing how many people move from counties with the ban to counties without and vice versa. Students may have other ideas.]*

Extension Prompts:

2. **Based on previous research showing evidence that trans fats can increase the risks for cardiovascular disease, what, in your opinion, should be done?** *[Have the students “vote with their feet” by assigning a choice to a corner of the room, for example: (A) Do more studies to check the risks but do*

not take any action yet. (B) Put a required warning label on foods containing trans fats to inform consumers. (C) Charge significant additional taxes on foods containing trans fats to try to dissuade people from buying them. (D) Ban the sale of foods with trans fats. Once students assemble, ask the individuals within a group to reflect on the reasons for their choice. Then ask each group to share their thoughts with other groups. Finally, have groups reflect again among themselves about the responses from other groups.]

3. **There is strong evidence that smoking or chewing tobacco greatly increases the risk of cancer as well as other life-threatening problems. What should be done?** [Again have students move to different corners of the room to choose their response: (A) Just do more studies. (B) Require warning labels. (C) Impose taxes on the product. (D) Ban sale of the product. Once students assemble, ask the individuals within a group to reflect on the reasons for their choice. Then ask each group to share their thoughts with other groups. Finally, have groups reflect again among themselves about the responses from other groups.]
4. **There is evidence that consuming too many drinks and foods that are high in sugar can increase the risk of diabetes. What should be done?** [Again have students move to different corners of the room to choose their response: (A) More studies. (B) Warning labels. (C) Taxes. (D) Ban the sale of certain products, as New York City tried with large sodas (Sugary Drinks Portion Cap Rule). Once students assemble, ask the individuals within a group to reflect on the reasons for their choice. Then ask each group to share their thoughts with other groups. Finally, have groups reflect again among themselves about the responses from other groups.]
5. **There is evidence that consuming too many foods that are high in salt can increase the risk of high blood pressure. What should be done?** [Again have students move to different corners of the room to choose their response: (A) More studies. (B) Warning labels. (C) Taxes. (D) Ban the sale of certain products. Once students assemble, ask the individuals within a group to reflect on the reasons for their choice. Then ask each group to share their thoughts with other groups. Finally, have groups reflect again among themselves about the responses from other groups.]
6. **Research and write about it: Outline what role the government currently takes in protecting people from food and drug risks. How does scientific research influence government policy and regulation? In your opinion, what is the proper role of government in protecting people from risks? What actions are reasonable and what actions encroach too much on personal choices?** [Different government agencies, such as the FDA and the Food Safety and Inspection Service (FSIS), play different roles in government regulation of food, drugs and other commercial products. At one end of the spectrum, it is wise for the government to ban private individuals from owning nuclear weapons. At the other end of the spectrum, should government require everyone to eat only healthy foods? Students can compare views, place themselves along the spectrum, and discuss.]

Experimental Design and Public Policy Question Bank

After thinking about the general design of the study and answering the article-based observation questions, what changes to the study design might show even better evidence linking trans fats regulation policies to cardiovascular disease risk?

Based on previous research showing evidence that trans fats can increase the risks for cardiovascular disease, what, in your opinion, should be done?

There is strong evidence that smoking or chewing tobacco greatly increases the risk of cancer as well as other life-threatening problems. What should be done?

There is evidence that consuming too many drinks and foods that are high in sugar can increase the risk of diabetes. What should be done?

There is evidence that consuming too many foods that are high in salt can increase the risk of high blood pressure. What should be done?

Research and write about it: Outline what role the government currently takes in protecting people from food and drug risks. How does scientific research influence government policy and regulation? In your opinion, what is the proper role of government in protecting people from risks? What actions are reasonable and what actions encroach too much on personal choices?