

Hamburgers—Plants or Beef?

Suggested Grade Level: 6-8

Time: Two 50-minute class periods

Subject: Science, Synthetic Materials, Natural Resources, English Language Arts, Writing, Speaking and Listening, Family and Consumer Science, Personal Resource Management, Nutrition, Health, Community Health, Consumer Health, Agriculture, Food Science

Overview: In this lesson, students will compare plant-based burgers to beef burgers by creating a scorecard to evaluate the patties, investigating their respective nutritional values, and listing the positive and negative aspects of both types.

Objectives:

1. Create a scorecard to evaluate food items.
2. List nutritional facts about both plant-based and beef burgers.
3. Compare the positive and negative aspects of both plant-based and beef burgers.

Background Information:

Beef plays a central role in the average American's diet. Approximately 98% of Americans purchase meat for their homes, and during the COVID-19 pandemic, grocery store meat sales increased by 19.2% (The). People love meat because it is satisfying and nutritious. A three-ounce serving of beef provides ten essential nutrients and approximately half of our daily protein requirements. Beef protein contains all of the amino acids our bodies cannot produce!

Protein does more than support our muscles. It also:

- Transports oxygen and nutrients throughout our bodies
- Promotes the growth and repair of our organs, tissues, and bones
- Supports a healthy immune system to fight disease and infections
- Provides the building blocks for the healing process for cuts, bruises, or other injuries and illnesses
- Provides satiety, that feeling of fullness when you eat a meal or snack

Beef also contains essential minerals and B vitamins:

- Minerals: iron, magnesium, zinc, copper, phosphorus, selenium
- B-vitamins: thiamin (B1), riboflavin (B2), niacin (B3), vitamin B6, vitamin B12

Another essential nutrient that we get from beef is iron. A small steak can provide approximately 13% of the recommended daily iron intake. Without enough iron in your diet, you can develop a condition called anemia (iron deficiency). Anemia prevents

oxygen from moving through your red blood cells, which can lead to low energy and poor fetal development for pregnant women. Iron is also why meat tastes like meat – heme, a molecular component of hemoglobin that contains iron, gives meat its characteristic savory taste (Harbstreet). People often describe beef as being high in fat and assume it isn't healthy. However, most of the fat in beef is unsaturated, which is heart-healthy. The guidelines for lean meat are no more than 4.5 grams of saturated fatty acids and less than 10 grams of total fat per serving (Beef). Twenty-nine cuts of beef meet these guidelines, as well as ground beef (95% lean, 5% fat).

A new wave of plant-based burgers has emerged. With advanced technology, researchers are developing a plant-based burger that resembles and tastes like a beef hamburger. As consumers consider environmental factors, health, and population growth, more people are trying an alternative burger. These burgers are becoming more available at restaurants, fast food stops, and in the aisles of grocery stores. The two most popular plant-based burgers are the Impossible Burger and Beyond Burger. Both companies' missions are to replace animal products with plant-based ones that are more environmentally friendly. The CEO of Impossible Foods says the company is on track to eliminate animal agriculture by 2035. They state that they are GMO-free and Vegan. They also claim that the plant-based burgers are more environmentally friendly. Beyond Meat claims its products use 99% less water and 93% less land. According to the Environmental Protection Agency, beef contributes 1.4 percent of greenhouse gas emissions. Studies on the environmental impact of growing enough soybeans and peas for these two products have not yet been conducted (Johnson). Beyond Burgers are made primarily with pea protein isolate. It provides 20 grams of protein and two grams of fiber, close to traditional ground beef. Beyond Burger includes 30% of our daily iron requirement, large amounts of phosphorus, and some vitamin C. The Beyond Burger has zero cholesterol, unlike ground beef, which has 100 milligrams. Beyond Burger also has less saturated and unsaturated fat than ground beef. However, it also contains 390 grams of sodium, while beef has 75 grams. According to a taste test, Beyond Beef tends to have a more veggie flavor. Because Beyond Burger doesn't contain heme or oxygenated iron, it will not develop a pink center. The Impossible Burger has a meaty texture and can be charred on the grill, similar to beef. It is juicy because of beef juice extract and includes heme, which is why it bleeds like beef. The Impossible Burger is made from soy protein concentrate, mung beans, and brown rice. The protein derived from this is a complete protein, meaning it contains all nine essential amino acids. This is important because few plant proteins are complete on their own. Additionally, Impossible Foods claims that their burger requires 75% less water and 95% less land, resulting in 87% fewer greenhouse gas emissions compared to conventional beef burgers (Capritto).

Both plant-based burgers have zero cholesterol and less fat than a traditional burger, which is better for our hearts. The biggest negative of both plant-based burgers is the high sodium content (Caldwell). Additionally, although they are both veggie burgers, they do not count as one of the five to seven servings of vegetables recommended by



the USDA (Panoff). Both plant-based burgers are heavily processed. There are two basic methods: thermoplastic extrusion and fiber spinning. Thermoplastic extrusion is the most common method of production. It is a cost-effective method and works well in large-scale productions. Extruders are used in various food formations, such as breakfast cereals, snacks like cheese puffs and curls, or any product that requires breaking down and reforming. The fiber-spinning method is more expensive and used for smaller batches of plant-based meat products. Both methods try to recreate the texture and taste of real beef (Research).

Plant-based burgers can be a hard sell for many Americans. The cost of plant-based burgers is higher than that of ground beef. For example, as of 2025, a Whopper at Burger King is \$8.99, while the Impossible Whopper costs \$9.99. Additionally, the taste and satisfaction of beef are part for American tradition. Historically, meat has been a staple in our diets for a long time, so we crave it and enjoy it as a central part of our meals. According to a research taste study conducted by K-State Meat Scientist Travis O'Quinn, consumers overwhelmingly preferred beef burgers over plant-based burgers in terms of taste. In one test, only 18% of consumers said they would be willing to buy the plant-based beef alternative because it was perceived as very dry and low in flavor. He also states that the plant-based burgers were more tender and shrank less than regular burgers (Melagares).

Kansas Industry Information:

"Livestock production is the largest contributor to the agriculture industry in Kansas," according to KDA's animal health sector report of 2021. Kansas ranks third for the largest number of cattle and calves, 6.1 million head as of summer 2024. Additionally, Kansas beef and beef products rank first, with over \$1.4 billion in exports. Kansas beef is a major contributor to the economy (Kansas). The total is \$14.8 billion and 66,789 jobs related to the beef industry.

Beef cattle production is the largest sector of Kansas agriculture, driven by ranchers who raise healthy livestock and produce high-quality beef. Kansas has the feed supply and pastureland to support raising beef. It is a top grain-producing state with a reliable feed supply and ample roughage, including hay, available. There are many cow-calf producers, stocker operations, feedyards, and processing plants. Kansas is centrally located and has a moderate climate, which helps with the supply chain and beef production. Kansas is also among the top states for beef processing, with three major beef processors and many smaller meat processing plants. Animal harvesting and meat processing in the state have an output of \$11.2 billion and 17,293 jobs (Kansas). Kansas has many agribusinesses that directly support beef cattle production. These include equipment manufacturers and equipment service providers, livestock feed manufacturers, livestock trailer manufacturers, and genetic companies.

Kansas is recognized as one of the best states for animal disease research. The National Bio and Agro-Defense Facility, in conjunction with the existing Biosecurity Research Institute located in Manhattan, Kansas, offers research capabilities for animal health and biosecurity to the state, the nation, and the world. Additionally, Kansas has



strong agricultural education with researchers and leaders in health, marketing, and promotion. Kansas State University Department of Animal Sciences and Industry is recognized throughout the cattle industry as one of the premier animal sciences programs in the nation. The strength of the state's university graduates and biosecurity system continues to provide more to the beef economy.

Materials:*Day 1: What Makes a Plant-Based Burger?*

- 1 package per group of: Beyond Burger, Impossible Burger, and Ground Beef (80% lean, 20% fat)

Day 2: Comparing Burgers

Per student

- Burger Scorecard (provided)
- Cooked Beyond Burger, Impossible Burger, and an 80/20 beef burger from Day 1
- Burger Comparison Chart (provided)
- Beef vs. Plant-Based Pros and Cons Worksheet (provided)

Instructional Format:

1. Review background information.
2. Conduct engagement exercise.
3. Lead a class discussion.
4. Complete the activity.
5. Conduct assessment exercise.

Engagement:

Ask students, "What's the best burger you have ever eaten? What made it so good? Are they from restaurants, or are they homemade?" List their responses on the board.

Discuss the common denominators among all of their answers. Now ask students, "If you were going to rate a burger, what items would you use in scoring?" Check these off. Then, ask if some items should be given more importance than others. With this information, create a class scorecard to use when evaluating your burgers.

(Alternatively, you can use the premade Burger Scorecard and instruct students to add points.)

Day 1: What Makes a Plant-Based Burger?**Procedures:***Discussion*

1. To introduce this lesson, show your class plant-based burger packages. Ask your class whether they know anything about plant-based burgers or have ever tried one.
2. Pull up this short video for your class. Leistritz Extrusion Technology: Leistritz Extrusion Technology - Production of Texturized Vegetable Proteins
<https://www.youtube.com/watch?v=cLn0QVpA29w>.



3. Then, play this short video. Impossible Foods: Heme - The Magic Ingredient in the Impossible Burger <https://www.youtube.com/watch?v=n6U4H8WC9jg>. Additionally, you can have students watch Heart of Gold Cuisine: TVP | Textured Vegetable Protein | How to Make TVP from Scratch <https://www.youtube.com/watch?v=XDPg4y-fmrs>.
4. Ask students to recall what heme is and what TSP/TVP stands for.
5. Emphasize that there are two primary methods of creating plant-based meat: thermoplastic extrusion, which involves breaking down and reshaping plant proteins using heat and pressure, and fiber spinning, which stretches plant proteins into long, thread-like strands to simulate muscle fibers. Refer to the "How are Plant-Based Burgers Made?" handout for an illustration of both methods.
6. Call your students' attention to the Beyond Meat and Impossible Burger packages and place the ground burger package next to them.
7. Instruct students to come up and study the similarities and differences. What ingredients are in the packages? Are they packaged differently? Are they advertised differently on the packaging?
8. Transition to emerging innovations by explaining that not all meat alternatives are plant-based. Define cultivated meat as real meat grown from animal cells in a lab, without raising or slaughtering animals. Note that this process uses biotechnology and is still being developed for commercial use.
9. Discuss the Career Information section. Say, "Let's think about who might be involved in creating these products. Did you know there's a career called a meat scientist? These professionals study the composition, safety, and quality of meat—and increasingly, they're also involved in developing plant-based alternatives like these burgers."
10. Optional: As an extension to this lesson, you could have students make TVP as shown in the "How to Make TVP from Scratch" video above.

Day 2: Comparing Burgers

Procedures:

Activity

1. For this part of the lesson, you can either cook the burgers before class or have your students do it if you have access to the necessary equipment and permissions.
2. Instruct your students to compare the three burgers. You can do this one of two ways: a) students use the burger packages to fill in the form as a group with information from the packaging, or b) students use the completed burger information chart (third page of document) to answer the questions.
3. Instruct your students to taste the cooked burgers independently and use their scorecards to determine the "best" burger.
4. Pass out the "Pros and Cons of Beef" form to your students and have them complete it individually, in small groups, or as a class.

5. As students list the pros and cons of beef and plant-based burgers, compile their scores for the best burger, and announce the results to the class.
6. Optional: An optional extension to this lesson could be researching and discussing cultivated or lab-created meat. CNBC: Lab-grown meat could make strides in 2022 as start-ups push for U.S. approval:
<https://www.cnbc.com/2022/01/23/lab-grown-meat-start-ups-hope-to-make-strides-in-2022.html>.

Vocabulary:

- **Plant-based meat:** (also called meat alternative or meat substitute) is a food product made from vegetarian or vegan ingredients, eaten as a replacement for meat.
- **Heme:** an iron-containing molecule that is essential for life. For animals, it is part of the hemoglobin inside red blood cells that binds to oxygen in the lungs and carries it to the tissues. For plants, it is leghemoglobin (legume hemoglobin), which is a protein that carries heme found in plants.
- **Leghemoglobin:** alters the flavor of certain meat alternatives to make them taste even more similar to meat ("simulates" animal blood in these meat alternatives, but made from plant-based sources)
- **Thermoplastic extrusion:** the process of manufacturing where material is broken down, forced through a die, heated, and cooled to create a formed product.
- **Fiber spinning:** the process of melting or adding water to create a liquid filament that forms a thread or yarn-like substance that can be formed into a mold.
- **Cultivated meat:** meat made in a lab from cells of real animals rather than animals grown on a farm.
- **TSP:** Textured Soy Protein
- **TVP:** Textured Vegetable Protein

Kansas Standards:

Next Generation Science Standards:

PS 1 Matter and Its Interactions

MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

LS 2 Ecosystems: Interactions, Energy, Dynamics

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

Language Arts

6th Grade

Writing

Text Types and Purposes

W.6.1 Write arguments to support claims with clear reasons and relevant evidence.

Research to Build and Present Knowledge

W.6.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

Language in Writing



W.6.10 Demonstrate command of and use knowledge of the conventions of standard English grammar and usage when writing.

W.6.11 Demonstrate command of the conventions of standard English capitalization, punctuation and spelling when writing.

Speaking and Listening

Comprehension and Collaboration

SL.6.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on sixth grade topics, texts and issues, building on others' ideas and expressing their own clearly.

Presentation of Knowledge and Ideas

SL.6.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume and clear pronunciation.

7th Grade

Writing

W.7.1 Write arguments to support claims with clear reasons and relevant evidence.

Production and Distribution of Writing

Research to Build and Present Knowledge

W.7.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.

Language in Writing

W.7.10 Demonstrate command of the conventions of standard English grammar and usage when writing.

W.7.11 Demonstrate command of the conventions of standard English capitalization, punctuation and spelling when writing.

Speaking and Listening

Comprehension and Collaboration

SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on seventh grade topics, texts and issues, building on others' ideas and expressing their own clearly.

Presentation of Knowledge and Ideas

SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume and clear pronunciation.

8th Grade

Writing

Text Types and Details

W.8.1 Write arguments to support claims with clear reasons and relevant evidence.

Research to Build and Present Knowledge

W.8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Language in Writing

W.8.10 Demonstrate command of the conventions of standard English grammar and usage when writing.

W.8.11 Demonstrate command of the conventions of standard English capitalization, punctuation and spelling when writing.

Speaking and Listening

Comprehension and Collaboration

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on eighth grade topics, texts and issues, building on others' ideas and expressing their own clearly.

Presentation of Knowledge and Ideas



SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning and well-chosen details; use appropriate eye contact, adequate volume and clear pronunciation.

Health Standards

Standard #3: Students will demonstrate the ability to access and analyze valid information and products and services to enhance health.

Community Health

8.1 Personal responsibility for community environmental issues.

Consumer Health

8.4 Informed consumer choices regarding health.

Nutrition

8.6 Food labels.

8.11 Food packaging and advertising.

8.13 Impact of food choices.

Family and Consumer Science Standards

3.0 Personal Resource Management Practice foundational personal management, consumer and personal finance skills to meet personal goals.

3.6 Investigate basic roles and responsibilities of the consumer.

3.7 Identify and apply wise consumer practices

5.0 Nutrition, Wellness and Food Preparation Demonstrate foundational nutrition, wellness and food preparation knowledge and skills to enhance individual and family well-being.

5.1 Apply nutrition basics in making healthy food choices

5.3 Apply wellness concepts to live a healthy lifestyle.

5.4 Apply nutrition concepts to prepare healthy food.

5.5 Analyze food sources and practices that impact the nutritional value of the food we consume.

National Agricultural Literacy Standards:

Agriculture and the Environment

- Recognize how climate and natural resources determine the types of crops and livestock that can be grown and raised for consumption (T1 6-8 g.)
- Recognize the factors of an agricultural system which determine its sustainability (T1 6-8 h.)

Plants and Animals for Food, Fiber & Energy

- Describe the differences in plants and animals used for food, clothing, shelter, and fuel before and after European settlement of the United States (T2 6-8 a.)
- Identify where labeling indicates the origin of food and fiber (fabric or clothing) (T2 6-8 f.)

Food, Health, and Lifestyle

- Evaluate food labels to determine food sources that meet nutritional needs (T3 6-8 b.)
- Evaluate serving size related to nutritional needs (T3 6-8 c.)
- Explain how factors, such as culture, convenience, access, and marketing affect food choices locally, regionally, and globally (T3 6-8 d.)
- Explain the benefits and disadvantages of food processing (T3 6-8 e.)
- Identify sources of agricultural products that provide food, fuel, clothing, shelter, medical, and other non-food products for their community, state, and/or nation (T3 6-8 i.)
- Identify the careers in food production, processing, and nutrition that are essential for a healthy food supply (T3 6-8 j.)

Culture, Economy, Geography, and Society

- Consider the economic value of agriculture in America (T4 6-8 a.)
- Distinguish between careers in production (farmers and ranchers) with those that directly involve consumers (business and nutrition) (T4 6-8 b.)

Science, Technology, Engineering and Math



- Discuss how technology has changed over time to help farmers/ranchers provide more food to more people (T5 6-8 d.)

Supporting Resources:

Heart of Gold Cuisine: TVP | Textured Vegetable Protein | How to Make TVP from Scratch: <https://www.youtube.com/watch?v=XDPg4y-fmrs>

Kansas Beef: Beef Insight Recording McNeil Finished: <https://www.youtube.com/watch?v=z5qiZQvqE3g&t=1273s>

K-State Extension: Beef Burgers vs. Plant-Based Patties https://www.feedlotmagazine.com/multimedia/beef-burgers-vs-plant-base-patties/video_39f09797-09e2-59cd-9dc4-184492748969.html

Stock Your Protein Pantry Fact Sheet (Beef Checkoff): <https://beef.widen.net/s/8fm6qq8hxb/stock-your-protein-pantry-fact-sheet>

Career Information: Meat Scientist

Meat Scientists make contributions to the meat industry. They complete industry-related research on color, flavor, texture, smell, and meat safety. To examine meat quality, these scientists use consumer sensory evaluation, muscle biology, and pre- and post-harvest factors. Meat scientists might be in a classroom teaching students, in a lab situation where they test and create, or with meatpackers, buyers, and consumers explaining the needs and future of the meat industry.

Assessment: Choose a burger and write a letter to the editor or give an 'elevator' speech that includes at least five ways the plant-based burger or beef burger is better.

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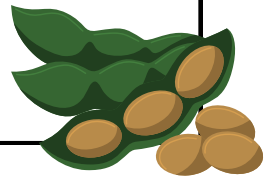
Which Burger is Best?

Beef

PROS...

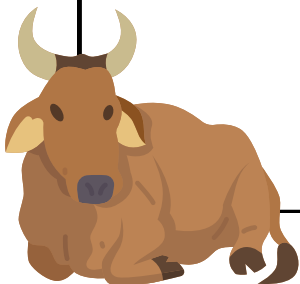
Plant-Based

PROS...



CONS...

CONS...



**Kansas Foundation
for AGRICULTURE
IN THE CLASSROOM**

Burger Scorecard

Criteria	Points	Beef Burger	Impossible Burger	Beyond Burger
Taste Juiciness Texture Flavor				
Appearance Color Eye Appeal				
Nutrition/Health Protein Iron Cholesterol % Daily Requirements				
Cost Price per Pound				
Environment Friendly Greenhouse Emissions: Low or High?				
Total Points				

What's the Difference?

Look at the chart below and answer the questions.

Beef	Impossible Burger	Beyond Burger
Ingredients: Beef	Ingredients: Water, Soy Protein Concentrate, Coconut Oil, Sunflower Oil, Natural Flavors, 2% or less of: Potato Protein, Methylcellulose, Yeast Extract, Cultured Dextrose, Food Starch Modified, Soy Leghemoglobin* (*this is what causes them to "bleed" like real beef), Salt, Soy Protein Isolate, Mixed Tocopherols (Vitamin E), Zinc Gluconate, Thiamine Hydrochloride (Vitamin B1), Sodium Ascorbate (Vitamin C), Niacin, Pyridoxine Hydrochloride (Vitamin B6), Riboflavin (Vitamin B2), Vitamin B12	Ingredients: Water, Pea Protein, Expeller-Pressed Canola Oil, Refined Coconut Oil, Rice Protein, Natural Flavors, Cocoa Butter, Mung Bean Protein, Methylcellulose, Potato Starch, Apple Extract, Pomegranate Extract, Salt, Potassium Chloride, Vinegar, Lemon Juice Concentrate, Sunflower Lecithin, Beet Juice Extract (for color).
Calories: 287	Calories: 240	Calories: 250
Fat: 23 grams	Fat: 14 grams	Fat: 18 grams
Saturated Fat: 8.5 grams	Saturated Fat: 8 grams	Saturated Fat: 6 grams
Cholesterol: 100 mg	Cholesterol: 0	Cholesterol: 0
Protein: 19 grams	Protein: 10 grams	Protein: 20 grams
Carbs: 0	Carbs: 3 grams	Carbs: 9 grams
Sodium: 75 mg	Sodium: 370 mg	Sodium: 390 mg

What's the Difference?

Note: the compared ground beef is 3 oz, 80% lean and 20% fat.

1. What is the main ingredient in both plant-based burgers?

2. What plants are one of the main ingredients in the two plant-based burgers?

Impossible Burger: _____ Beyond Burger: _____

3. What chemical element shows the most significant difference between a beef burger and the two plant-based burgers?

4. Unsaturated fats are beneficial because they can help improve blood cholesterol levels, reduce inflammation, and stabilize heart rhythms. How many grams of unsaturated fat are in each of the following?

Beef Burger: _____ Impossible Burger: _____ Beyond Burger: _____

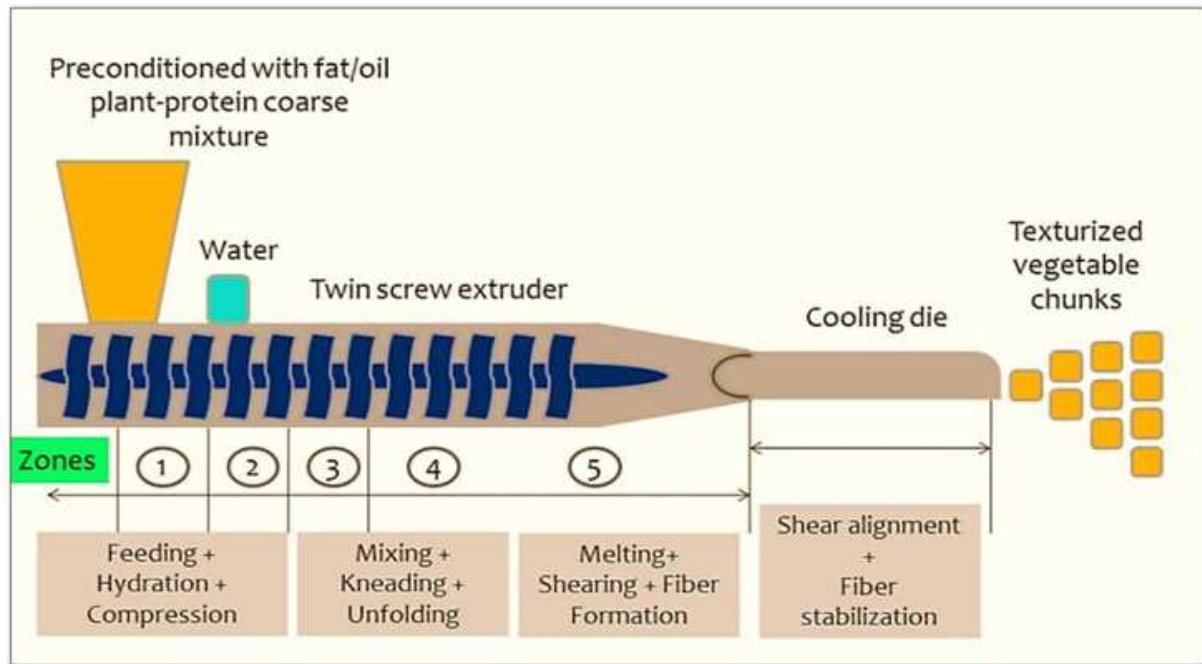
5. Why do you think the vitamins are in the ingredient list of the Impossible Burger?

6. What fatty substance found primarily in beef rather than plant-based beef can hurt our hearts?

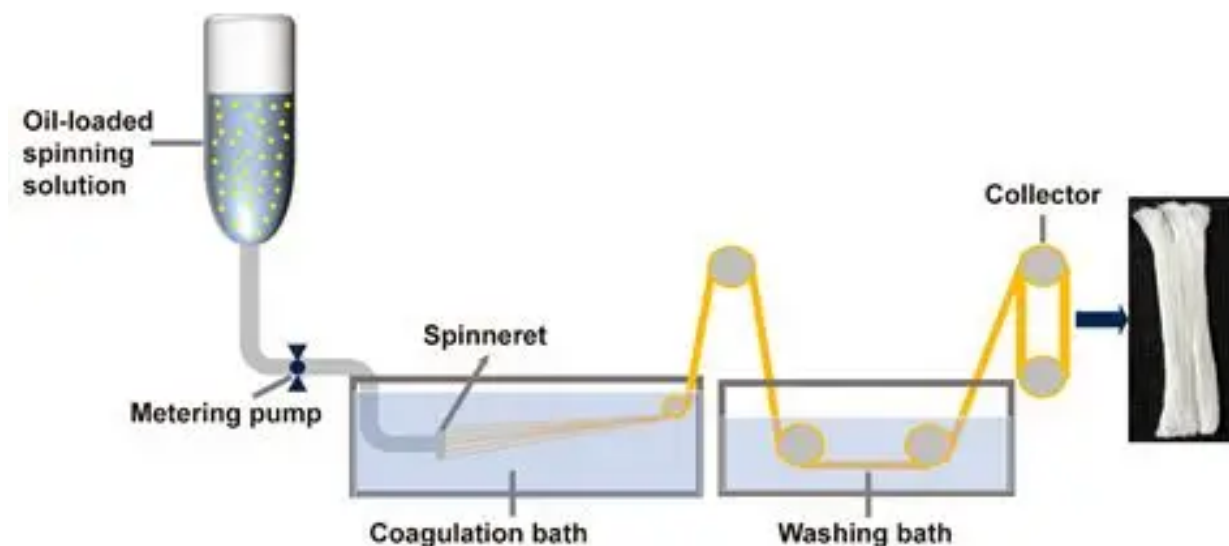
7. Why do you think coloring or the look of blood is added to both of the plant-based burgers?



How are Plant-Based Burgers Made?



The above image is an example of the extrusion method of creating meat alternatives, such as the Beyond Burger. This method is easier and more cost-effective for large-scale production.



This image provides an example of the wet fiber spinning method, which can also be used to create meat alternatives. It is more expensive and better for small batches.