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Carbs, Protein, and Fat in the Kitchen

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Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

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Three Nutrients, Three Completely Different Jobs

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Three Nutrients, Three Completely Different Jobs

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Carbohydrates: Simple, Complex, and the Fiber Exception

Carbohydrates come in two broad forms, and the difference is essentially a matter of chain length. Simple carbohydrates are short. They include single sugars such as glucose, fructose, and galactose, and double sugars such as sucrose, which is table sugar, lactose, which is milk sugar, and maltose. Simple sugars digest quickly and

reach the bloodstream fast. Complex carbohydrates are long chains of glucose units and include starch and fiber. Starch is what a potato, a grain of rice, and a piece of bread are mostly made of, and the body breaks it down into glucose more slowly than it breaks down a spoonful of sugar. Fiber is the exception that makes carbohydrates interesting. Fiber is also a long chain of sugar units, but humans lack the enzymes to break the bonds, so it passes through largely intact. That failure to digest is the whole point. Soluble fiber, found in oats, beans, barley, and apples, dissolves into a gel that slows digestion, blunts the rise in blood glucose after a meal, and helps lower blood cholesterol. Insoluble fiber, found in wheat bran, vegetable skins, and whole grains, does not dissolve. It adds bulk and keeps things moving through the digestive tract. The recommended daily value for fiber is 28 grams, and most Americans take in roughly half that, which is one of the more consistent gaps in the national diet. In the kitchen, carbohydrates are also the browning nutrient. Sugars caramelize when heated past about 320 degrees Fahrenheit, turning brown and developing hundreds of new flavor compounds that were not present in the raw ingredient at all.

Protein: Complete, Incomplete, and What Heat Does to It

Protein is built from twenty amino acids strung together in specific sequences, and nine of those amino acids are essential, meaning the body cannot build them and has to take them in from food. A protein source that supplies all nine essential amino acids in useful amounts is called a complete protein. Animal foods, meaning meat, poultry, fish, eggs, and dairy, are complete, and so are soy and quinoa. Most plant proteins are incomplete, meaning they are low in one or more essential amino acids. Beans run low in methionine and grains run low in lysine, which is why beans and rice, or hummus and pita, or peanut butter on bread, complete each other. These are called complementary proteins. An older idea held that complementary proteins had to be eaten in the same meal, and that turned out to be unnecessary. The body maintains a pool of amino acids, so getting the full range across a day is sufficient. In the kitchen, protein behaves in a way that is easy to watch. Heat, acid, and mechanical force all cause denaturation, which means the folded protein molecule unravels and then bonds with its neighbors. That is exactly what happens when a clear, runny egg white turns opaque and firm in a pan, and it is also what happens when citrus juice firms up raw fish in ceviche without any heat at all. Denaturation is

not damage and it does not destroy nutritional value. Overdoing it, however, squeezes water out and produces tough meat, rubbery eggs, and dry chicken, which is the single most common protein failure in a school foods lab.

Fat: The Nutrient That Got Blamed for Everything

Fats are classified by their chemical structure, and the practical shorthand is what they do at room temperature. Saturated fats are solid at room temperature and come mostly from animal sources such as butter, lard, and the fat in meat and dairy, plus two plant exceptions, coconut oil and palm oil. Unsaturated fats are liquid at room temperature. Monounsaturated fats appear in olive oil, canola oil, avocados, and most nuts. Polyunsaturated fats appear in corn, soybean, and sunflower oils, in walnuts and flaxseed, and in fatty fish, which is also where the omega-3 fats live. Dietary guidance has recommended keeping saturated fat under ten percent of daily calories and replacing some of it with unsaturated fat, which is a shift in the type of fat rather than a demand to remove fat. Artificial trans fat is the one category that got removed outright. Produced by partially hydrogenating liquid oils to make them solid and shelf-stable, trans fat raised harmful cholesterol and lowered protective cholesterol at the same time, and the Food and Drug Administration withdrew its approved status so that it is no longer permitted in the United States food supply. In the kitchen, fat does jobs nothing else can do. Water in an open pot cannot get hotter than its boiling point, but fat can be heated well past it, which is why frying browns food that boiling only softens. It dissolves flavor compounds that water cannot touch, which is why a sauce made with some fat tastes fuller. It carries vitamins A, D, E, and K into the body, meaning a genuinely fat-free salad delivers less of its own vitamins than the same salad dressed with oil.

Smoke Points, Emulsions, and Why the Pan Matters

Every fat has a smoke point, meaning the temperature at which it stops behaving like a cooking fat and starts breaking down, releasing visible smoke and a sharp, bitter flavor that will not cook back out. Butter smokes around 350 degrees Fahrenheit because of the milk solids suspended in it. Extra virgin olive oil smokes somewhere around 375 to 405 degrees depending on quality. Refined oils such as canola and peanut hold up closer to 400 to 450 degrees, and avocado oil runs higher still. This is why a recipe calling for a hard sear specifies a refined oil rather than butter, and why a pan of butter that has gone brown and acrid cannot be rescued. Fat and water

are the other kitchen problem worth understanding, because they do not mix. An emulsion is a temporary or stabilized suspension of one inside the other, and it is how vinaigrette, mayonnaise, and hollandaise exist at all. Whisking breaks fat into droplets small enough to stay suspended, but without help they find each other and separate again within minutes. An emulsifier, meaning a molecule with a water-friendly end and a fat-friendly end, holds the droplets apart. Egg yolk contains lecithin and is the classic example, which is why mayonnaise built on yolk stays together for weeks while a plain oil and vinegar mixture separates while a student is still carrying it to the table. Mustard and honey work the same way in smaller measure. None of this is trivia. It is the reason a dressing holds, a sauce stays glossy, and a sear browns instead of steams.

Key Information: Macronutrients at the Stove

Detail	Information
Simple Carbohydrates	Single and double sugars such as glucose, sucrose, lactose
Complex Carbohydrates	Long glucose chains: starch and fiber
Fiber Daily Value	28 grams; most Americans take in roughly half
Essential Amino Acids	9 of the 20 must come from food
Complete Protein	Supplies all 9 essential amino acids; meat, dairy, egg, soy, quinoa
Denaturation	Heat, acid, or force unfolds protein; sets egg whites and ceviche
Saturated Fat Guidance	Keep under 10 percent of daily calories
Smoke Point	Butter about 350 F; refined oils about 400-450 F

Case Study: The Fat-Free Salad Experiment

Kayla decided her lab group's salad would be the healthiest one in the room, so she cut the oil out of the vinaigrette entirely and shook up straight red wine vinegar with mustard and pepper. The dressing tasted sharp enough to make her partner cough. Twenty minutes later the group reported they were hungry again. Her teacher used the salad as the day's discussion. "You removed 240 calories," she said, "and you also removed the delivery vehicle." The spinach in the bowl was full of vitamins A and K, both fat-soluble, and with no fat in the dressing far less of either would actually be absorbed. The fat would also have carried the flavor compounds in the mustard and pepper across the whole bowl instead of leaving them concentrated and harsh. Kayla remade the dressing the next day with three parts olive oil to one part vinegar. "It tastes like actual food now," she admitted, "and I stayed full through fifth period."

1. Explain what Kayla's teacher meant by calling the oil a delivery vehicle, using what the reading says about fat-soluble vitamins.

2. Kayla's first dressing separated almost immediately once she added oil on day two. Explain why, and name what would hold it together.

Multiple Choice

1. Beans and rice are called complementary proteins because together they:
   a) Supply all nine essential amino acids between them
   b) Digest more slowly than any animal protein does
   c) Provide both soluble and insoluble fiber in one dish
   d) Contain fewer calories than either food does alone

2. A clear egg white turning opaque and firm in a hot pan is an example of:

a) Hydrogenation

b) Caramelization

c) Denaturation

d) Emulsification

3. A recipe calls for a hard sear and specifies canola oil instead of butter because butter:

a) Contains no saturated fat and cannot brown meat

b) Has a lower smoke point and will burn at searing heat

c) Is an emulsion and will separate when it is heated

d) Carries fat-soluble vitamins that break down at high heat

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Soluble Fiber	A) The unfolding of protein by heat, acid, or force so it sets and firms
2. ___ Complete Protein	B) Fiber that gels, slowing digestion and helping lower blood cholesterol
3. ___ Denaturation	C) The temperature at which a cooking fat breaks down and turns bitter
4. ___ Smoke Point	D) A molecule with a water-friendly end and a fat-friendly end
5. ___ Emulsifier	E) A food supplying all nine amino acids the body cannot build itself

Fill-in-the-Blank

1. Nine of the twenty _____ acids must come from food.

2. Sugars brown and develop new flavor through _____.

3. Egg yolk holds a dressing together because it contains _____.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain why fiber is a carbohydrate even though the body cannot digest it.

2. Explain why overcooked chicken turns dry, using what you know about protein.

3. Explain why frying browns food while boiling only softens it.