COMPLETE NUTRITION SCIENCE COURSE

Grades 7 - 10 | Full Semester Curriculum

18 Unit Lesson Plans | Student Notebook | Food Label Analysis

Dietary Guidelines | Myth-Busting Cards | Quizzes & Keys

A Deep Dive Into the Science of Nutrition

Distinct from PE Health Units - Focused on Scientific Principles

UM Printables

TABLE OF CONTENTS

Complete Nutrition Science Course

This full-semester course provides a comprehensive, science-focused exploration of nutrition for students in Grades 7-10. Unlike typical PE health units that cover basic wellness concepts, this course dives deep into the biochemistry of nutrients, the physiology of digestion, the regulatory framework of food labeling, and the critical analysis of nutrition claims. Students will develop scientific literacy skills essential for making informed dietary decisions.

Course Structure

The course is organized into 18 units spanning eight thematic modules. Each unit includes a detailed lesson plan with objectives, key vocabulary, direct instruction content, guided practice activities, and assessment options. The pacing assumes approximately 90 class periods over a full semester (18 weeks x 5 days/week).

Module	Units	Focus Area
1: Foundations	1	Introduction to Nutrition Science
2: Macronutrients	2, 3, 4, 5	Carbohydrates, Proteins, Fats, Water
3: Digestion	6, 7	Digestive System, Enzymes & Absorption
4: Micronutrients	8, 9	Vitamins, Minerals
5: Food Literacy	10, 11	Food Labels, Label Analysis Lab
6: Guidelines & Myths	12, 13, 14	US Guidelines, International Comparison, Myths
7: Food Systems	15	Food Systems & Sustainability
8: Application	16, 17, 18	Lifespan Nutrition, Personal Plan, Review

Standards Alignment

This course aligns with the following national standards and frameworks:

- **NGSS (Next Generation Science Standards):** MS-LS1-3 (body systems), MS-LS1-7 (food processing for energy), HS-LS1-2 (cellular processes)
- **National Health Education Standards:** Standard 1 (core concepts), Standard 3 (accessing information), Standard 5 (decision making), Standard 7 (health practices)
- **Common Core ELA-Literacy:** RST.6-8.3, RST.9-10.4 (science technical reading), WHST.6-8.1, WHST.9-10.2 (science writing)
- **AAAS Benchmarks:** 6E/M1-M4 (human organism - physical health), 8A/M1 (agriculture)

Overarching Course Objectives

1. Explain the chemical structure and biological function of each macronutrient and micronutrient category.

2. Describe the complete digestive process from ingestion through absorption and elimination, including enzymatic roles.
3. Analyze and interpret Nutrition Facts labels, ingredient lists, and nutrient content claims using scientific criteria.
4. Compare and contrast dietary guidelines from multiple countries and evaluate the evidence base behind recommendations.
5. Identify and debunk common nutrition myths using scientific reasoning and evidence evaluation.
6. Evaluate the environmental, economic, and social dimensions of food systems and their impact on nutrition.
7. Design a personal nutrition plan grounded in scientific principles that accounts for individual needs and preferences.
8. Apply critical thinking skills to evaluate nutrition information in media, advertising, and popular culture.

Course Materials Included

18 Unit Lesson Plans - Detailed plans with objectives, vocabulary, activities, and assessments.

Student Nutrition Science Notebook - 60 pages of structured notes, reflections, and activities.

Food Label Analysis Activity Set - 10 real-world food labels for analysis and comparison.

Dietary Guideline Comparison Activity - Multi-country guideline comparison with critical thinking questions.

Nutrition Myth-Busting Cards - 20 cards presenting common myths with scientific rebuttals.

Personal Nutrition Plan Project - Multi-step project with rubric and reflection components.

Unit Quizzes & Answer Keys - Comprehensive assessments for each unit.

PART II: UNIT LESSON PLANS (UNITS 1-18)

UNIT 1: Introduction to Nutrition Science

Duration	5 class periods (1 week)
Prerequisites	None - this is the foundational unit
Key Question	What is nutrition science, and why does it matter?

Learning Objectives

1. Define nutrition science and distinguish it from popular nutrition advice.
2. Identify the six classes of nutrients and categorize them as macronutrients or micronutrients.
3. Explain the concept of essential nutrients and why the body cannot synthesize them.
4. Describe the scientific method as it applies to nutrition research.
5. Evaluate the difference between correlation and causation in nutrition studies.

Key Vocabulary

Nutrition science	The study of how food and nutrients affect the body, health, and disease.
Nutrient	A substance in food that provides energy, supports growth, or regulates body processes.
Macronutrient	Nutrients required in large amounts: carbohydrates, proteins, fats, and water.
Micronutrient	Nutrients required in small amounts: vitamins and minerals.
Essential nutrient	A nutrient the body cannot synthesize in sufficient quantities; must be obtained from diet.
Calorie (kcal)	A unit of energy; the energy needed to raise 1 kg of water by 1 degree C.
Correlation	A statistical relationship between two variables that does not imply causation.
Causation	A relationship where one variable directly produces a change in another.
Peer review	The process by which scientific studies are evaluated by other experts before publication.
Bioavailability	The proportion of a nutrient that is absorbed and available for use by the body.

Direct Instruction

Day 1: What Is Nutrition Science?

Nutrition science is the systematic study of how food components interact with the human body at molecular, cellular, and systemic levels. It encompasses biochemistry, physiology, genetics, and epidemiology. Unlike casual nutrition advice found in media, nutrition science relies on the scientific method: forming hypotheses, conducting controlled experiments, analyzing data, and submitting findings to peer review. Students should understand that nutrition is a relatively young science - many mechanisms are still being studied, which is why recommendations sometimes change as evidence accumulates.

Day 2: The Six Classes of Nutrients

All nutrients fall into six categories: carbohydrates, proteins, fats (lipids), vitamins, minerals, and water. The first three provide energy (carbohydrates and proteins provide 4 kcal/g, fats provide 9 kcal/g; alcohol provides 7 kcal/g but is not a nutrient). Vitamins and minerals do not provide energy but are essential for metabolic processes. Water is unique - it provides no calories but is the most critical nutrient for survival. Nutrients are further classified as essential (must be consumed) or non-essential (the body can synthesize them). For example, the body can make vitamin D with sun exposure but cannot make vitamin C, making vitamin C essential and vitamin D conditionally essential depending on sun exposure.

Day 3: The Scientific Method in Nutrition Research

Nutrition research uses several study designs, each with strengths and limitations. In vitro studies test nutrients in lab dishes - useful for mechanism but not real-world application. Animal studies allow controlled conditions but may not translate to humans. Observational studies (cohort, case-control) identify correlations in large populations but cannot prove causation. Randomized controlled trials (RCTs) are the gold standard - participants are randomly assigned to groups, minimizing confounding variables. Meta-analyses combine data from multiple studies for stronger conclusions. Students must learn that a single study - especially an observational one - rarely changes dietary guidelines.

Day 4: Correlation vs. Causation

One of the most critical skills in nutrition literacy is understanding the difference between correlation and causation. Just because two variables are associated does not mean one causes the other. For example, countries with higher chocolate consumption tend to have more Nobel laureates - but chocolate does not cause Nobel prizes; both may be linked to wealth and education. Confounding variables, reverse causation, and coincidence can all produce misleading correlations. The Bradford Hill criteria provide a framework for evaluating whether an observed association is likely causal: strength, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment, and analogy.

Day 5: Nutrition in the Media

Students learn to critically evaluate nutrition claims in media using a systematic approach: (1) Identify the source - is it a peer-reviewed journal, government agency, or a commercial entity? (2) Check the study design - was it an RCT or an observational study? How many participants? (3) Look for conflicts of interest - who funded the research? (4) Evaluate the headline - does it accurately reflect the study findings or exaggerate them? (5) Check if the findings have been replicated. The class will practice with real examples of exaggerated or misleading nutrition headlines.

Guided Practice Activities

Nutrient Classification Sort: Students receive 30 food component cards (e.g., "vitamin C," "glucose," "iron," "amino acids") and sort them into macronutrient and micronutrient categories, then further classify by energy-yielding vs. non-energy-yielding.

Study Design Analysis: In small groups, students read summaries of three nutrition studies (one RCT, one cohort study, one in vitro) and identify the study type, strengths, limitations, and whether causation can be claimed.

Headline Fact-Check: Students are given 5 real nutrition headlines and must identify: the likely study design, potential confounders, whether causation is justified, and how they would investigate further.

Essential vs. Non-Essential Debate: Students research why certain nutrients are essential (evolutionary loss of biosynthetic pathways) and present arguments for why the body can make some but not others.

Assessment

Formative: Exit ticket - classify 8 nutrients as macro/micro and essential/non-essential. Formative: Think-pair-share on correlation vs. causation examples. Summative: Unit 1 Quiz (see Part VIII). Performance: Media literacy short essay - evaluate a nutrition claim using scientific criteria.

Differentiation

Support: Provide a nutrient classification reference chart. Use visual study design diagrams. Offer sentence starters for the media essay. **Extension:** Students research the Bradford Hill criteria in depth and apply them to a current nutrition debate (e.g., sugar and heart disease). Design a hypothetical RCT to test a nutrition question.

UNIT 2: Carbohydrates - The Energy Macronutrient

Duration	5 class periods (1 week)
Prerequisites	Unit 1 - foundational nutrient concepts
Key Question	How do carbohydrates fuel the body, and why does their type matter?

Learning Objectives

1. Describe the chemical structure of carbohydrates (carbon, hydrogen, oxygen in a 1:2:1 ratio).
2. Classify carbohydrates as monosaccharides, disaccharides, oligosaccharides, or polysaccharides with examples.
3. Explain the difference between simple and complex carbohydrates and their metabolic effects.
4. Describe the roles of fiber (soluble and insoluble) in digestion and health.
5. Calculate the caloric contribution of carbohydrates in a meal using the 4 kcal/g conversion.

Key Vocabulary

Monosaccharide	The simplest carbohydrate unit; examples: glucose, fructose, galactose.
Disaccharide	Two monosaccharides bonded; examples: sucrose (glucose+fructose), lactose (glucose+galactose), maltose (glucose+glucose).
Polysaccharide	Long chains of monosaccharides; examples: starch, glycogen, cellulose.
Glycogen	The storage polysaccharide in animals; found in liver and muscle tissue.
Starch	The storage polysaccharide in plants; composed of amylose (linear) and amylopectin (branched).
Cellulose	A structural polysaccharide in plant cell walls; humans cannot digest it (dietary fiber).
Glycemic index	A measure of how quickly a carbohydrate-containing food raises blood glucose levels (0-100 scale).
Soluble fiber	Fiber that dissolves in water to form a gel; found in oats, beans, apples; lowers cholesterol.
Insoluble fiber	Fiber that does not dissolve in water; found in whole grains, vegetables; promotes bowel regularity.
Lactose intolerance	Inability to fully digest lactose due to insufficient lactase enzyme production.

Direct Instruction

Day 1: Carbohydrate Chemistry

Carbohydrates are organic molecules composed of carbon (C), hydrogen (H), and oxygen (O) atoms, typically in a ratio of 1:2:1 (general formula: CH_2O). They serve as the body's primary energy source, particularly for the brain and red blood cells, which rely almost exclusively on glucose. Carbohydrates are classified by the number of sugar units: monosaccharides (1 unit), disaccharides (2 units), oligosaccharides (3-10 units), and polysaccharides (10+ units). Glucose is the central monosaccharide in human metabolism - all dietary carbohydrates are ultimately converted to glucose for energy or stored as glycogen. Three key monosaccharides are glucose (blood sugar), fructose (fruit sugar), and galactose (milk sugar component).

Day 2: Simple vs. Complex Carbohydrates

Simple carbohydrates (monosaccharides and disaccharides) are quickly digested and absorbed, causing rapid increases in blood glucose. They occur naturally in fruits (fructose) and milk (lactose) but are also added to processed foods as refined sugars (sucrose, high-fructose corn syrup). Complex carbohydrates (polysaccharides like starch) take longer to digest because their glycosidic bonds must be enzymatically broken. This slower digestion provides sustained energy and a more moderate glycemic response. The distinction between "simple" and "complex" is useful but oversimplified - the glycemic index provides a more precise measure of a food's actual blood glucose impact. For example, some complex carbs (like white bread) have a higher GI than some simple carbs (like fructose in fruit).

Day 3: Fiber - The Indigestible Carbohydrate

Dietary fiber includes all non-digestible carbohydrates and lignin that are intrinsic and intact in plants. Soluble fiber (beta-glucan in oats, pectin in apples, gums in beans) dissolves in water to form viscous gels that slow gastric emptying, reduce cholesterol absorption, and moderate blood glucose spikes. Insoluble fiber (cellulose in whole grains, hemicellulose in vegetables) adds bulk to stool and speeds transit through the colon. The Adequate Intake (AI) for fiber is 25 g/day for females and 38 g/day for males (ages 14-18). Most Americans consume only 15 g/day. Increasing fiber too rapidly can cause bloating and discomfort - a gradual increase with adequate water is recommended. Fiber also serves as a prebiotic, feeding beneficial gut bacteria that produce short-chain fatty acids (butyrate, propionate, acetate) with anti-inflammatory properties.

Day 4: Glycogen Storage and Blood Glucose Regulation

After a meal, blood glucose rises, triggering the pancreas to release insulin. Insulin promotes glucose uptake by cells and stimulates glycogenesis - the conversion of glucose to glycogen in the liver (approximately 100 g capacity) and skeletal muscles (approximately 300-500 g capacity). When blood glucose drops between meals, the pancreas releases glucagon, which stimulates glycogenolysis - the breakdown of glycogen back to glucose. Liver glycogen can release glucose into the bloodstream, but muscle glycogen can only be used locally by muscle cells. When glycogen stores are full (after a high-carb meal with low activity), excess glucose is converted to fat through de novo lipogenesis. The blood glucose regulation system is a classic negative feedback loop.

Day 5: Lactose Intolerance and Carbohydrate-Related Conditions

Lactose intolerance results from insufficient lactase enzyme production in the small intestine. Lactase breaks lactose into glucose and galactose for absorption. Without adequate lactase, lactose passes undigested to the large intestine, where bacteria ferment it, producing gas, bloating, and diarrhea. This is distinct from a milk allergy, which is an immune response to milk proteins (casein, whey). Lactase non-persistence is the norm for most of the world's adult population - lactase persistence (the ability to digest lactose into adulthood) is a genetic adaptation that evolved in populations with a long history of dairy farming, primarily in Northern European and some East African populations. Other carbohydrate-related conditions include galactosemia (a rare genetic disorder preventing galactose metabolism) and G6PD deficiency (affects red blood cell carbohydrate metabolism).

Guided Practice Activities

Carbohydrate Structure Models: Students use marshmallows and toothpicks to build models of monosaccharides, disaccharides, and polysaccharides, demonstrating condensation and hydrolysis reactions.

Food Label Carb Analysis: Students examine 5 food labels and calculate: total carbs, sugar vs. added sugar, fiber content, and net carbs (total carbs minus fiber).

Fiber Tracking Challenge: Students track their fiber intake for 3 days and compare to the AI recommendation, then propose realistic strategies to increase fiber.

GI Comparison Lab: Using provided GI data, students rank 15 foods from highest to lowest GI and identify patterns (processing level, fiber content, ripeness).

Assessment

Formative: Quick-write - explain the difference between soluble and insoluble fiber. Formative: Carb classification exit ticket - classify 10 carbohydrates by type. Summative: Unit 2 Quiz (see Part VIII). Performance: Fiber intake analysis report with evidence-based recommendations.

Differentiation

Support: Provide a carbohydrate classification flowchart. Use color-coded molecular model kits. Pair with peer tutor for fiber tracking activity. **Extension:** Research the biochemistry of artificial sweeteners and their effects on insulin response. Investigate resistant starch as a "third type" of fiber.

UNIT 3: Proteins - The Building Blocks

Duration	5 class periods (1 week)
Prerequisites	Units 1-2
Key Question	How do proteins build and repair the body, and what makes a protein "complete"?

Learning Objectives

1. Describe the chemical structure of amino acids and explain how peptide bonds form proteins.
2. Differentiate between essential, non-essential, and conditionally essential amino acids.
3. Define complete and incomplete proteins and identify complementary protein combinations.
4. Explain the roles of proteins in the body beyond muscle building (enzymes, hormones, antibodies, transport).
5. Calculate protein requirements using body weight and the RDA of 0.8 g/kg for adolescents.

Key Vocabulary

Amino acid	The building block of proteins; 20 standard amino acids are used in human protein synthesis.
Essential amino acid	An amino acid that cannot be synthesized by the body and must be obtained from diet; 9 of 20 are essential.
Peptide bond	A covalent bond linking the carboxyl group of one amino acid to the amino group of another, releasing water.
Complete protein	A food protein containing all 9 essential amino acids in adequate proportions; examples: meat, fish, eggs, dairy, soy, quinoa.
Incomplete protein	A food protein lacking adequate amounts of one or more essential amino acids; most plant proteins.
Complementary proteins	Two or more incomplete protein sources that, when combined, provide all essential amino acids (e.g., rice and beans).
Denaturation	The unfolding of a protein's 3D structure due to heat, acid, or other factors; does not break peptide bonds.
RDA (protein)	0.8 g/kg body weight/day for sedentary adults; 0.85-1.0 g/kg for adolescents during growth.
Nitrogen balance	The difference between nitrogen intake (from protein) and nitrogen excretion; positive during growth, negative during starvation.
Transamination	The process of transferring an amino group from one amino acid to a keto acid to form a new amino acid.

Direct Instruction

Day 1: Amino Acid Structure and Peptide Bonds

Every amino acid consists of a central carbon atom (alpha carbon) bonded to four groups: an amino group (-NH2), a carboxyl group (-COOH), a hydrogen atom, and a variable side chain (R group) that determines the amino acid's chemical properties. The R group can be nonpolar (hydrophobic), polar (hydrophilic), acidic (negatively charged at physiological pH), or basic (positively charged). When two amino acids join, the carboxyl group of one reacts with the amino group of another in a condensation reaction, forming a peptide bond and releasing a water molecule. Chains of amino acids are called peptides (2-50 amino acids) or proteins (50+ amino acids). The sequence of amino acids is the primary structure - it determines everything about the protein's function.

Day 2: Protein Structure - From Primary to Quaternary

Proteins have four levels of structure. Primary structure is the linear sequence of amino acids, determined by the genetic code. Secondary structure results from hydrogen bonding between backbone atoms, forming alpha helices (coiled) and beta sheets (folded). Tertiary structure is the overall 3D shape, stabilized by interactions between R groups: hydrophobic interactions, hydrogen bonds, ionic bonds, and disulfide bridges (covalent bonds between cysteine residues). Quaternary structure occurs when multiple polypeptide chains (subunits) assemble into a functional complex (e.g., hemoglobin has 4 subunits). Denaturation disrupts secondary, tertiary, and quaternary structure without breaking peptide bonds - this is what happens when you cook an egg white (it turns from clear to opaque as proteins unfold and aggregate).

Day 3: Essential Amino Acids and Protein Quality

Of the 20 standard amino acids, 9 are essential: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. The body cannot synthesize these because it lacks the biochemical pathways to construct their carbon skeletons. Some amino acids are conditionally essential - normally the body can make them, but under certain conditions (premature birth, severe illness), synthesis is insufficient: arginine, cysteine, glutamine, tyrosine, glycine, proline, and serine. Protein quality is measured by: (1) Biological Value (BV) - how efficiently absorbed protein is used by the body; (2) Protein Digestibility-Corrected Amino Acid Score (PDCAAS) - the WHO standard that evaluates protein based on essential amino acid content and digestibility. Animal proteins and soy score highest (PDCAAS near 1.0). Most plant proteins are limited in one essential amino acid (e.g., grains are low in lysine, legumes are low in methionine) but can be combined to provide complete amino acid profiles.

Day 4: Protein Functions in the Body

Proteins serve vastly more roles than just muscle building. Enzymes (e.g., amylase, lactase) catalyze biochemical reactions. Hormones (e.g., insulin, growth hormone) regulate body processes. Antibodies (immunoglobulins) defend against pathogens. Transport proteins (e.g., hemoglobin carries oxygen, transferrin carries iron) move substances through the bloodstream. Structural proteins (e.g., collagen in skin and bones, keratin in hair and nails) provide physical support. Contractile proteins (actin and myosin) enable muscle movement. Buffer proteins help maintain blood pH. Fluid balance is maintained by plasma proteins (albumin) that create osmotic pressure. When protein intake is insufficient, the body catabolizes muscle tissue to obtain amino acids for critical functions - this is why severe protein deficiency (kwashiorkor) causes muscle wasting, edema, and immune suppression even when total caloric intake may be adequate.

Day 5: Protein Requirements and Calculations

The Recommended Dietary Allowance (RDA) for protein is 0.8 g per kg of body weight per day for adults, but adolescents need more (0.85-1.0 g/kg) to support growth spurts. Athletes may need 1.2-2.0 g/kg depending on sport and training intensity. To calculate protein needs: a 55 kg adolescent needs approximately 55 x 0.85 = 46.75 g/day (using the adolescent RDA). Protein provides 4 kcal/g, so 46.75 g x 4 = 187 kcal from protein per day. If total daily calories are 2,200 kcal, protein contributes approximately 8.5% of energy - well below the Acceptable Macronutrient Distribution Range (AMDR) of 10-35%. The upper limit for protein is generally considered 2.0 g/kg for healthy adolescents; excess protein is not stored as protein but is converted to glucose (gluconeogenesis) or fat. Contrary to popular belief, high protein intake does not damage healthy kidneys, though people with existing kidney disease must limit protein.

Guided Practice Activities

- **Amino Acid Card Sort:** Students sort 20 amino acid cards into essential, non-essential, and conditionally essential categories.
- **Protein Complementing Challenge:** Given a list of plant foods with their limiting amino acids, students design 3 meals combining complementary proteins.
- **Protein Calculation Workshop:** Students calculate their own protein RDA, then analyze a day's food intake to compare actual vs. recommended protein.
- **Egg Denaturation Demo:** Observe protein denaturation by adding vinegar (acid) to egg whites and by heating - students describe observations in terms of structural changes.

Assessment

Formative: Protein structure exit ticket - match structure level to its description. Formative: Quick calculation - given body weight, calculate protein RDA and kcal from protein. Summative: Unit 3 Quiz (see Part VIII). Performance: Complementary protein meal plan with nutritional justification.

Differentiation

Support: Provide a protein structure diagram with labels. Use a step-by-step calculation worksheet for protein RDA. Offer a word bank for complementary protein meals. **Extension:** Research PDCAAS scores for various proteins and create a ranking chart. Investigate how genetic mutations in amino acid sequences cause diseases (sickle cell anemia).

UNIT 4: Fats & Lipids - Essential Energy Reserves

Duration	5 class periods (1 week)
Prerequisites	Units 1-3
Key Question	Why are fats the most energy-dense nutrient, and how do different fats affect health?

Learning Objectives

1. Describe the chemical structure of a triglyceride (one glycerol molecule bonded to three fatty acids).
2. Classify fatty acids as saturated, monounsaturated, or polyunsaturated based on their carbon chain structure.
3. Explain the difference between cis and trans fatty acids and the health implications of each.
4. Identify the two essential fatty acids (linoleic and alpha-linolenic) and their roles in the body.
5. Differentiate between HDL and LDL cholesterol and explain their significance for cardiovascular health.

Key Vocabulary

Lipid	A group of organic compounds that are insoluble in water but soluble in organic solvents; includes fats, oils, phospholipids, and sterols.
Triglyceride	The major form of stored fat in the body and in food; composed of a glycerol backbone bonded to three fatty acids.
Fatty acid	An organic acid consisting of a carbon chain with a carboxyl group at one end; the building block of fats.
Saturated fatty acid	A fatty acid with no double bonds between carbon atoms; fully "saturated" with hydrogen atoms; typically solid at room temperature.
Unsaturated fatty acid	A fatty acid with one or more double bonds between carbon atoms; typically liquid at room temperature; includes monounsaturated (one double bond) and polyunsaturated (two or more).
Trans fatty acid	An unsaturated fatty acid where the hydrogen atoms are on opposite sides of the double bond, created during partial hydrogenation; associated with increased cardiovascular risk.
Essential fatty acid	A fatty acid that must be obtained from the diet because the body cannot synthesize it; includes linoleic acid (omega-6) and alpha-linolenic acid (omega-3).
Cholesterol	A sterol lipid essential for cell membranes, bile, and hormone synthesis; found only in animal foods; carried in blood by lipoproteins.
Lipoprotein	A complex of lipids and proteins that transports fats in the bloodstream; includes HDL (high-density lipoprotein) and LDL (low-density lipoprotein).
Emulsification	The process of breaking large fat globules into smaller droplets, increasing surface area for digestive enzymes; facilitated by bile.

Direct Instruction

Day 1: Lipid Chemistry and Triglycerides

Lipids are a diverse group of compounds that share one critical property: they are insoluble in water (hydrophobic). The most common dietary lipids are triglycerides, which make up approximately 95% of the fats we eat. A triglyceride consists of a glycerol molecule (a 3-carbon alcohol) bonded to three fatty acids via condensation reactions. When the body needs to break down a triglyceride for energy, hydrolysis cleaves the fatty acids from the glycerol backbone. Fats are the most energy-dense macronutrient, providing 9 kcal per gram - more than twice the energy of carbohydrates or proteins. This high energy density evolved as a survival advantage: storing energy as fat requires less mass and volume than storing it as glycogen because glycogen binds significant water (approximately 3 g water per 1 g glycogen).

Day 2: Saturated vs. Unsaturated Fats

Fatty acids are classified by the presence and number of double bonds in their carbon chains. Saturated fatty acids have no double bonds - every carbon atom is bonded to the maximum number of hydrogen atoms. This straight, rigid structure allows saturated fat molecules to pack tightly together, making them solid at room temperature. They are found predominantly in animal products (butter, lard, meat fat) and tropical oils (coconut, palm). Unsaturated fatty acids have one or more double bonds, which create kinks in the carbon chain, preventing tight packing and making these fats liquid at room temperature. Monounsaturated fatty acids (MUFAs) have one double bond (e.g., oleic acid in olive oil and avocados). Polyunsaturated fatty acids (PUFAs) have two or more double bonds (e.g., linoleic acid in vegetable oils, EPA and DHA in fish). Replacing saturated fats with unsaturated fats is consistently associated with reduced cardiovascular risk in large-scale studies.

Day 3: Trans Fats and Cholesterol

Most naturally occurring unsaturated fatty acids have a "cis" configuration, where hydrogen atoms are on the same side of the double bond, creating a pronounced kink. During industrial partial hydrogenation (adding hydrogen to liquid vegetable oils to make them semi-solid), some double bonds are converted to a "trans" configuration where hydrogens are on opposite sides. This straightens the chain, giving trans fats a higher melting point and longer shelf life. However, trans fats raise LDL cholesterol and lower HDL cholesterol, doubling the risk of cardiovascular disease compared to saturated fats. In 2015, the FDA determined that partially hydrogenated oils are not "generally recognized as safe" (GRAS), and as of 2018, they have been effectively banned from the US food supply, though trace amounts (less than 0.5 g per serving) may still appear. Cholesterol is a sterol, not a fat. It is essential for cell membrane structure, bile acid synthesis, and steroid hormone production. Dietary cholesterol (found only in animal foods) has less impact on blood cholesterol than previously believed - saturated and trans fats are the primary dietary drivers of elevated blood cholesterol.

Day 4: Essential Fatty Acids and Lipid Functions

The body can synthesize most fatty acids but cannot produce two: linoleic acid (an omega-6 PUFA) and alpha-linolenic acid (ALA, an omega-3 PUFA). These are essential and must come from the diet. Linoleic acid is abundant in vegetable oils (sunflower, safflower, corn). ALA is found in flaxseeds, chia seeds, walnuts, and canola oil. The body can convert ALA to the longer-chain omega-3s EPA and DHA, but this conversion is very inefficient (approximately 5-10% for EPA and less than 5% for DHA). EPA and DHA are best obtained directly from fatty fish or algae-based supplements. Omega-3s reduce inflammation, lower triglycerides, and are critical for brain development and function. Beyond energy storage, lipids serve many functions: phospholipids form cell membranes (the lipid bilayer), cholesterol is a precursor for vitamin D and steroid hormones, fats insulate organs and maintain body temperature, and fat-soluble vitamins (A, D, E, K) require dietary fat for absorption.

Day 5: Lipoproteins and Cardiovascular Health

Because fats are insoluble in blood, they must be transported in lipoprotein complexes - particles with a hydrophobic lipid core and a hydrophilic protein shell. Chylomicrons transport dietary fats from the intestine to cells. Very-low-density lipoproteins (VLDL) carry triglycerides synthesized by the liver. LDL delivers cholesterol to cells throughout the body; when LDL levels are excessive, cholesterol can deposit in artery walls, forming

PART VIII: UNIT QUIZZES & ANSWER KEYS

Unit Quizzes & Answer Keys

The following section contains unit quizzes for all 18 units. The Answer Keys are grouped separately at the end of this section for teacher use, allowing quizzes to be printed and distributed without the answers.

STUDENT QUIZZES

Unit 1 Quiz: Introduction to Nutrition Science

Name: ________________________ Date: ________________ Score: ________ / 5

1. Define the term "essential nutrient." Provide two examples.

2. Explain the difference between correlation and causation in nutrition research.

3. Which of the following is a micronutrient? (A) Protein (B) Carbohydrate (C) Vitamin C (D) Fat

4. How many calories per gram does fat provide? (A) 4 (B) 7 (C) 9 (D) 12

5. Describe the role of peer review in nutrition science.

Unit 2 Quiz: Carbohydrates - The Energy Macronutrient

Name: ________________________ Date: _______________ Score: _______ / 5

1. What is the general chemical ratio of atoms in a carbohydrate molecule?

2. Explain the primary difference between soluble and insoluble fiber regarding their action in the body.

3. Which hormone lowers blood glucose levels, and which hormone raises them?

4. Which polysaccharide is the storage form of glucose in animals? (A) Starch (B) Cellulose (C) Glycogen (D) Fructose

5. What causes lactose intolerance, and how is it different from a milk allergy?

Unit 3 Quiz: Proteins - The Building Blocks

Name: ________________________ Date: _______________ Score: _______ / 5

1. What four components are bonded to the central alpha-carbon in every amino acid?

2. Explain the difference between a complete and an incomplete protein.

3. Define protein denaturation. Give one example of how it occurs.

4. How many essential amino acids must be obtained from the diet? (A) 5 (B) 9 (C) 11 (D) 20

5. Calculate the protein RDA (in grams) for a 60 kg adult using the standard 0.8 g/kg recommendation.

5. Atrophic gastritis is inflammation of the stomach lining that reduces stomach acid. This impairs the release of B12 from food and the absorption of minerals like calcium and iron.

ANSWER KEY: Unit 17 - Personal Nutrition Plan Project

1. Basal Metabolic Rate (BMR), Physical Activity, and the Thermic Effect of Food (TEF).

2. AMDR stands for Acceptable Macronutrient Distribution Range. Carbs: 45-65%, Fat: 20-35%, Protein: 10-35%.

3. Analyzing a baseline record reveals current habits, identifies nutrient gaps or excesses, and provides objective data to inform realistic, targeted changes rather than guessing.

4. (B) 330 g. (2,400 x 0.55 = 1,320 kcal. 1,320 / 4 kcal/g = 330 g).

5. An initial draft may hit calorie targets but fall short on micronutrients like calcium or iron, or exceed sodium limits. Adjustments are necessary to ensure all nutritional targets are met simultaneously while keeping the plan realistic.

ANSWER KEY: Unit 18 - Course Review & Scientific Reflection

1. Fat is emulsified by bile in the small intestine, then broken down by lipase into fatty acids and monoglycerides. These are absorbed into intestinal cells, reassembled into triglycerides, packaged into chylomicrons, and enter the lacteal (lymph) before entering the bloodstream.

2. Bioavailability means that consuming a nutrient does not guarantee absorbing it. Nutrient interactions (e.g., Vitamin C enhancing iron, calcium blocking iron) mean that the total dietary context matters, not just the individual foods eaten.

3. This is the "appeal to nature fallacy." Natural does not mean safe; many natural plants are toxic or interfere with medications. Safety depends on dose and chemical properties, not origin.

4. (C) Randomized controlled trial (RCT). RCTs minimize confounding variables by randomly assigning participants to intervention or control groups.

5. (Answers will vary) Reflection should articulate a specific concept that was previously misunderstood (e.g., realizing carbs don't inherently cause weight gain, or that detox diets are biologically impossible) and how the scientific reality changes their perspective.

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