

## Nutrition Science

### Macronutrients and Metabolism Quiz – Answer Key

1. **(C) Fats (9 kcal/g).** Fats are the most energy-dense macronutrient, providing more than twice the energy of carbohydrates or proteins per gram.
2. **(B) How quickly a food raises blood glucose levels.** GI compares foods to pure glucose (GI=100). High-GI foods cause rapid spikes; low-GI foods cause gradual increases.
3. **(B) Cannot be synthesized by the body and must be obtained from diet.** Nine essential amino acids (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine) must come from food.
4. **(C) Trans fatty acids.** Trans fats raise LDL cholesterol, lower HDL cholesterol, and increase inflammation—all risk factors for cardiovascular disease. Largely banned in food production.
5. **(C) Coenzymes in metabolic reactions.** B vitamins (thiamin, riboflavin, niacin, B6, B12, folate, etc.) serve as coenzymes for energy metabolism, DNA synthesis, and other reactions.
6. **False.** Fiber is not digested by human enzymes. Soluble fiber is fermented by gut bacteria in the colon; insoluble fiber passes through largely intact, adding bulk to stool.
7. **True.** Complete proteins (eggs, meat, fish, dairy, soy, quinoa) provide all nine essential amino acids. Most plant proteins are incomplete (lacking or low in one or more).
8. **True.** BMR accounts for 60-75% of total daily energy expenditure in sedentary individuals, covering vital functions: breathing, circulation, cell production, brain function.

#### 9. Glucose Metabolism Overview:

##### Glycolysis (cytoplasm):

- Glucose (6C) → 2 Pyruvate (3C)
- Net yield: 2 ATP + 2 NADH
- Does not require oxygen (anaerobic possible)
- 10-step enzyme-catalyzed pathway

##### Pyruvate Processing (mitochondrial matrix):

- Pyruvate → Acetyl-CoA (2C) + CO<sub>2</sub>
- Produces 1 NADH per pyruvate
- Requires oxygen (aerobic)

##### Citric Acid Cycle/Krebs Cycle (mitochondrial matrix):

- Acetyl-CoA (2C) combines with oxaloacetate (4C)
- 8-step cycle regenerates oxaloacetate
- Per Acetyl-CoA: 3 NADH + 1 FADH<sub>2</sub> + 1 GTP + 2 CO<sub>2</sub>

- Completes oxidation of glucose carbons

**Oxidative Phosphorylation (inner mitochondrial membrane):**

- Electron transport chain accepts electrons from NADH, FADH<sub>2</sub>
- Creates proton gradient across membrane
- ATP synthase uses gradient to produce ATP
- Oxygen is final electron acceptor (forms H<sub>2</sub>O)
- Produces 26-28 ATP per glucose

**Total yield: 30-32 ATP per glucose molecule**

**10. Saturated Fats:**

- Structure: No double bonds; carbon chain fully “saturated” with hydrogens
- Solid at room temperature (straight chains pack tightly)
- Sources: Animal fats (butter, lard), coconut oil, palm oil
- Health effects: Raise LDL cholesterol; associated with increased cardiovascular risk

**Unsaturated Fats:**

- Structure: One (mono-) or more (poly-) double bonds; creates “kinks”
- Liquid at room temperature (kinks prevent tight packing)
- Cis configuration (hydrogens same side) is natural form
- Sources: Olive oil (mono), fish, nuts, seeds (poly)
- Health effects: Lower LDL, may raise HDL; omega-3s reduce inflammation

**Trans Fats:**

- Structure: Unsaturated but with trans configuration (hydrogens opposite sides)
- Behave like saturated fats (straighter chain)
- Created by partial hydrogenation of vegetable oils
- Sources: Processed foods, margarine (historically), fried foods
- Health effects: Worst for cardiovascular health—raise LDL, lower HDL, increase inflammation; largely banned

**Dietary recommendations:** Replace saturated and trans fats with unsaturated fats. Emphasize omega-3 sources. Limit processed foods containing industrial trans fats.