Domain I: Principles of Nutrition

Case Study Applications

Case Study 1 — Digestive Function & Nutrient Absorption

Case Overview

A 38-year-old woman reports chronic bloating, loose stools, and fatigue after meals. Her diet is low in fiber and high in refined carbohydrates and dairy. Stool testing reveals steatorrhea and low pancreatic elastase. She notices that fatty foods make her feel “sluggish and nauseated.”

Connection to Domain I

This case highlights **the physiology of digestion and absorption**, particularly how pancreatic and biliary function impact macronutrient metabolism. It directly aligns with **Domain I competencies related to digestive physiology, macronutrient absorption, and nutrient transport.**

Functional Lab Markers to Consider

- **Comprehensive Stool Analysis or GI-MAP** (elastase, steatocrit, fecal fat, sIgA)
- **Serum Micronutrients:** Vitamins A, D, E, K
- **Serum Albumin & Prealbumin:** for protein malabsorption
- **Serum B12, Folate, and Iron Studies:** for secondary malabsorption
- **Liver Enzymes (ALT, AST, ALP, GGT):** to rule out hepatic contribution

Key Learning Concepts

- Low pancreatic elastase indicates exocrine pancreatic insufficiency → inadequate lipase and protease secretion.
- Fat malabsorption leads to calorie loss and fat-soluble vitamin deficiencies (A, D, E, K).
- Steatorrhea indicates impaired bile or pancreatic enzyme output.
- Vitamin D deficiency contributes to bone weakness; Vitamin K deficiency may cause bruising or bleeding.
- Medium-chain triglycerides (MCTs) can be absorbed directly via the portal vein, bypassing the need for micelle formation.

Sample Questions

1. Which of the following deficiencies is most likely in a client with steatorrhea and low pancreatic elastase?
A. Vitamin C
B. Vitamin B12
C. Vitamin D
D. Vitamin B6

✅ **Correct Answer:** C — *Vitamin D*
Rationale: Fat-soluble vitamins (A, D, E, K) require adequate bile and pancreatic lipase for absorption; steatorrhea indicates impaired fat digestion.

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2. Which of the following laboratory findings best supports a diagnosis of fat malabsorption?
A. Elevated serum bilirubin
B. Elevated fecal fat
C. Low serum amylase
D. Elevated lipase

✅ **Correct Answer:** B — *Elevated fecal fat*
Rationale: Increased fecal fat confirms that dietary lipids are not being adequately digested or absorbed, consistent with pancreatic or biliary insufficiency.

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3. Which intervention is most appropriate to support digestion and absorption in this client?
A. High-fiber diet and probiotics
B. Supplementation with pancreatic enzymes and bile salts
C. Calcium and vitamin C supplementation
D. Low-fat, low-protein diet

✅ **Correct Answer:** B — *Pancreatic enzymes and bile salts*
Rationale: Enzyme replacement and bile support directly address impaired fat and protein digestion, the root cause of her symptoms.

Case Study 2 — Microbiome and Metabolic Health

Case Overview

A 50-year-old woman with obesity and insulin resistance reports irregular bowel movements, persistent sugar cravings, and low energy. Her diet is high in refined carbohydrates and low in

fiber. Stool testing reveals low *Bifidobacterium* and *Akkermansia muciniphila*, a high *Firmicutes/Bacteroidetes* ratio, and elevated *Streptococcus* species.

Connection to Domain I

This case illustrates **the relationship between the gut microbiome, macronutrient metabolism, and inflammatory pathways**, directly addressing **Domain I competencies on microbial effects on metabolism, inflammatory signaling, and digestion.**

Functional Lab Markers to Consider

- **GI-MAP or Comprehensive Stool Test:** microbial diversity, SCFA levels, beta-glucuronidase
- **HbA1c and Fasting Insulin:** metabolic status
- **High-sensitivity CRP (hs-CRP):** systemic inflammation
- **Zonulin:** intestinal permeability
- **LPS (Endotoxin) and Secretory IgA:** mucosal immune activation

Key Learning Concepts

- A high Firmicutes/Bacteroidetes ratio enhances caloric extraction and promotes weight gain.
- Dysbiosis increases gut permeability, allowing LPS (endotoxin) to trigger systemic inflammation.
- Chronic inflammation contributes to insulin resistance and altered leptin signaling.
- SCFAs (especially butyrate) from bacterial fermentation regulate glucose metabolism, satiety, and gut barrier function.
- Dietary fiber, polyphenols, and probiotics enhance microbial diversity and lower inflammatory tone.

Sample Questions

1. Which of the following is most likely to improve microbial diversity in this client?
A. Reducing all carbohydrates and following a ketogenic diet
B. Increasing soluble fiber and polyphenol intake
C. Eliminating all dairy and fermented foods
D. Supplementing with digestive enzymes only

✅ **Correct Answer:** B — *Increasing soluble fiber and polyphenols*
Rationale: Soluble fibers (prebiotics) and polyphenols support the growth of beneficial bacteria such as *Bifidobacterium* and *Akkermansia*, restoring diversity.

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2. Which bacterial metabolite plays a key role in enhancing insulin sensitivity and maintaining gut barrier integrity?
A. Lactic acid
B. Butyrate
C. Acetaldehyde
D. Ethanol

✅ **Correct Answer:** B — *Butyrate*
Rationale: Butyrate, a short-chain fatty acid produced by microbial fermentation, enhances tight junction integrity and improves insulin signaling.

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3. Which mechanism best explains the link between gut dysbiosis and metabolic endotoxemia?
A. Increased SCFA production raises inflammation
B. Elevated intestinal permeability allows LPS to enter circulation
C. Decreased fiber intake lowers gastric acid secretion
D. Overgrowth of *Akkermansia* increases hepatic glucose output

✅ **Correct Answer:** B — *LPS entry into circulation*
Rationale: Dysbiosis weakens the gut barrier, allowing lipopolysaccharides (LPS) from Gram-negative bacteria to enter the bloodstream, triggering inflammation and insulin resistance.

Case Study 3 — Pregnancy & Nutritional Demands

Case Overview

A 29-year-old woman, 20 weeks pregnant with her first child, reports fatigue, mild anemia, and dizziness. Her diet is primarily plant-based with limited red meat. She experienced early nausea and relies on fortified cereals and prenatal gummies.

Connection to Domain I

This case integrates **life cycle nutrition and nutrient requirements during pregnancy**, which aligns with **Domain I competencies related to physiology, energy balance, and nutritional needs throughout the life cycle.**

Functional Lab Markers to Consider

- **CBC with Differential:** hemoglobin, hematocrit, MCV, ferritin
- **Iron Studies:** serum iron, TIBC, transferrin saturation

- **B12 and Folate:** for megaloblastic anemia screening
- **Serum Choline and Iodine (urinary):** fetal brain development
- **Vitamin D and Omega-3 Index:** for fetal bone and neurological health
- **Thyroid Panel:** TSH, Free T4, T3 (iodine sufficiency context)

Key Learning Concepts

- Plasma volume increases during pregnancy → physiologic anemia if iron intake is insufficient.
- Iron, folate, B12, choline, DHA, and iodine are key nutrients for fetal development.
- Protein needs increase to ~1.1 g/kg/day in pregnancy.
- Insufficient folate or B12 during early pregnancy increases neural tube defect risk.
- DHA and iodine are critical for neurodevelopment and thyroid hormone synthesis.

Sample Questions

1. Which nutrient deficiency most likely explains this client's fatigue and anemia?
A. Vitamin D
B. Folate
C. Iron
D. Calcium

✅ **Correct Answer:** C — *Iron*
Rationale: Increased blood volume during pregnancy raises iron requirements. Low ferritin with anemia indicates iron deficiency, a common cause of fatigue and dizziness.

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2. Which nutrient is essential for fetal brain development and may be lacking in plant-based diets?
A. Choline
B. Selenium
C. Magnesium
D. Zinc

✅ **Correct Answer:** A — *Choline*
Rationale: Choline supports neural tube closure and memory development. It is found in eggs, liver, and some meats—commonly low in plant-based diets.

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3. Why is plasma volume expansion a normal adaptation during pregnancy?
A. It prevents hypertension and maintains sodium balance.
B. It supports uteroplacental blood flow and fetal nutrient delivery.

C. It enhances thermoregulation and reduces cortisol.
D. It decreases insulin resistance.

✅ **Correct Answer:** B — *Supports uteroplacental blood flow*
Rationale: Plasma volume expansion ensures adequate oxygen and nutrient delivery to the fetus, a normal physiologic adaptation to pregnancy.