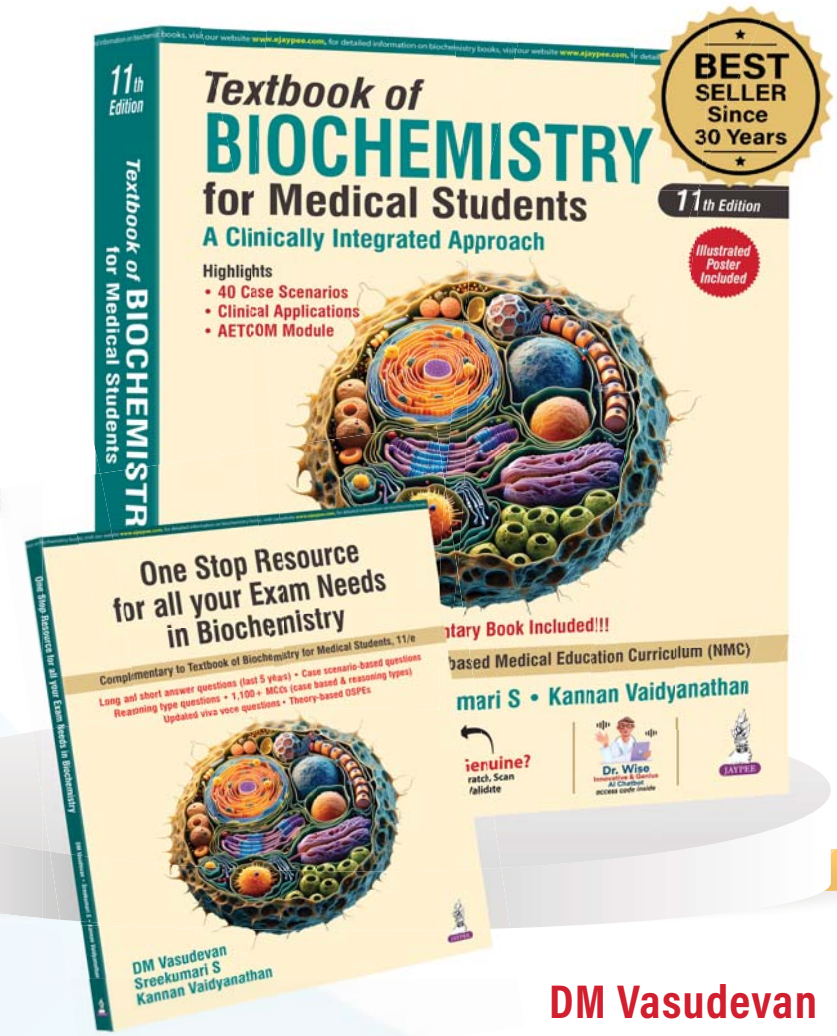

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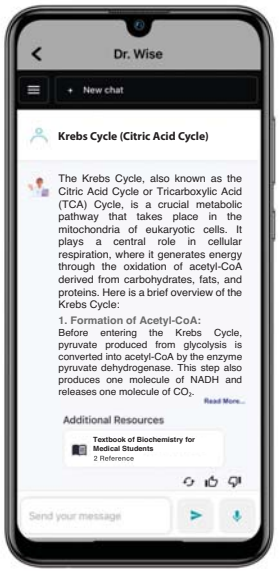

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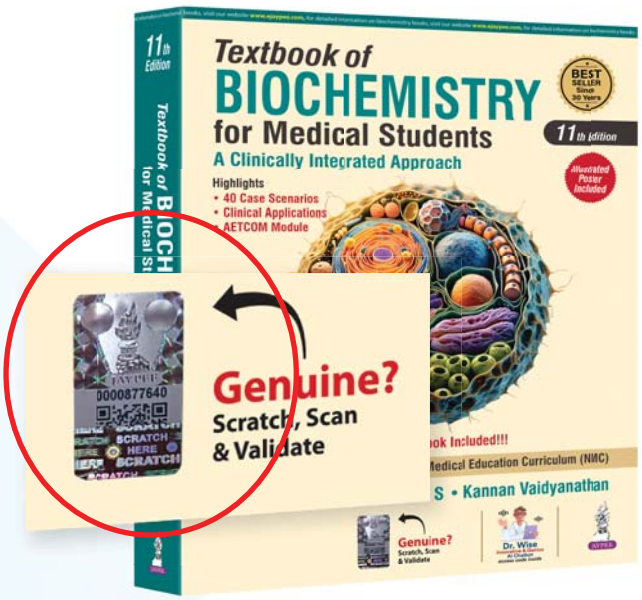

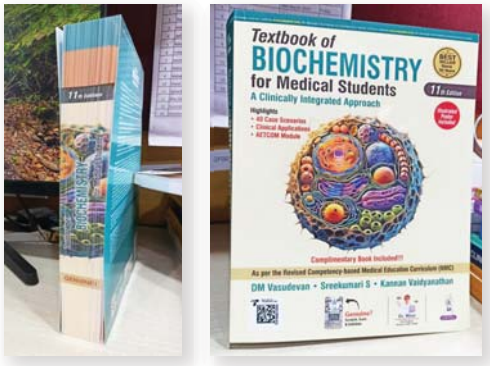

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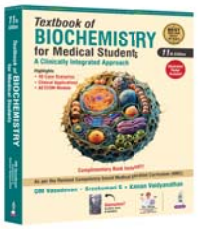


SAMPLE PAGES — MAIN BOOK

Specific Learning Objectives

The learner will be able to:

- Outline the digestion of carbohydrates
- Describe the absorption of glucose and glucose transporters
- Trace the glycolysis pathway and explain its regulation
- Calculate the energy yield from glycolysis
- Define the Cori cycle and BPG shunt and state their clinical relevance
- Mention the role of pyruvate as a metabolic junction
- Describe gluconeogenesis and malate shuttle
- Explain the significance of gluconeogenesis and glucose alanine cycle
- Enumerate the substrates for gluconeogenesis
- Describe the synthesis and degradation of glycogen
- Explain the regulation of glycogen metabolism and the role of cyclic AMP
- Tabulate major glycogen storage diseases and their salient features
- Trace the hexose monophosphate shunt pathway
- State the metabolic and clinical significance of the shunt pathway
- Outline the glucuronic acid pathway and essential pentosuria
- Enumerate the steps and significance of the polyol pathway
- Outline the metabolism of fructose
- Mention the inborn errors associated with fructose metabolism
- Describe galactose metabolism
- Enumerate the biochemical abnormalities and manifestations in galactosemia
- Outline the metabolism of alcohol
- Explain the harmful effects of alcoholism and toxicity of methanol
- List the amino sugars
- Describe the structure and functions of glycoproteins
- Differentiate the blood group antigens
- Enumerate the structural components of proteoglycans
- List the congenital disorders of glycosylation and mucopolysaccharidoses
- Tabulate the inborn errors associated with metabolism of carbohydrates

Scan me for Chapter's NMC Competencies or, for detailed competencies, please refer Prelims page xxxvii

Each chapter begins with clear and Specific Learning Objectives that highlight key takeaways.

Metabolic Path

DIGESTION OF CARBOHYDRATES

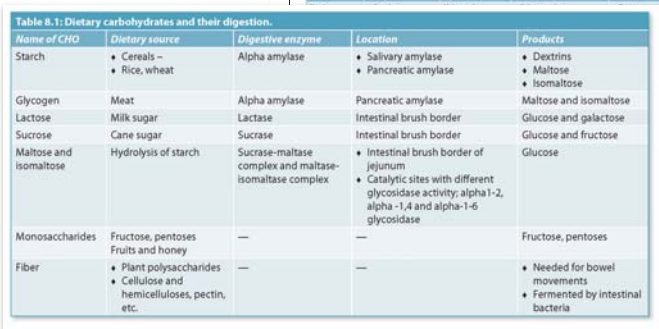
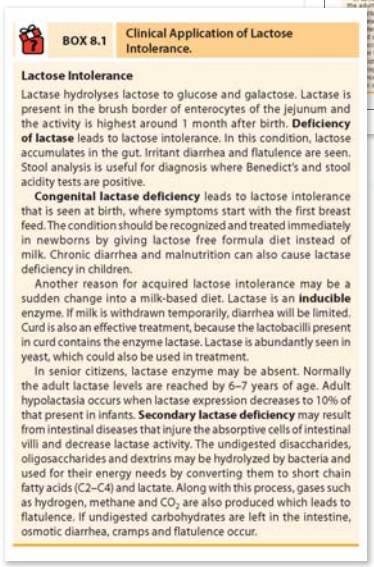


Table 8.1: Dietary carbohydrates and their digestion.

Name of CHO	Dietary source	Digestive enzyme	Location	Products
Starch	• Cereals – • Rice, wheat	Alpha amylase	• Salivary amylase • Pancreatic amylase	• Dextrins • Maltose • Isomaltose
Glycogen	Meat	Alpha amylase	Pancreatic amylase	Maltose and isomaltose
Lactose	Milk sugar	Lactase	Intestinal brush border	Glucose and galactose
Sucrose	Cane sugar	Sucrase	Intestinal brush border	Glucose and fructose
Maltose and isomaltose	Hydrolysis of starch	Sucrase-maltase complex and maltase-isomaltase complex	• Intestinal brush border of jejunum • Catalytic sites with different glycosidase activity; alpha 1-2, alpha -1,4 and alpha-1-6 glycosidase	Glucose
Monosaccharides	Fructose, pentoses Fruits and honey	—	—	Fructose, pentoses
Fiber	• Plant polysaccharides • Cellulose and hemicelluloses, pectin, etc.	—	—	• Needed for bowel movements • Fermented by intestinal bacteria

Additional tables and boxes, are added for last-minute revision and quick reference.



BOX 8.1 Clinical Application of Lactose Intolerance.

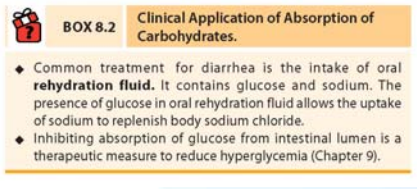
Lactose Intolerance

Lactase hydrolyses lactose to glucose and galactose. Lactase is present in the brush border of enterocytes of the jejunum and the activity is highest around 1 month after birth. **Deficiency of lactase** leads to lactose intolerance. In this condition, lactose accumulates in the gut. Irritant diarrhea and flatulence are seen. Stool analysis is useful for diagnosis where Benedict's and stool acidity tests are positive.

Congenital lactase deficiency leads to lactose intolerance that is seen at birth, where symptoms start with the first breast feed. The condition should be recognized and treated immediately in newborns by giving lactose free formula diet instead of milk. Chronic diarrhea and malnutrition can also cause lactase deficiency in children.

Another reason for acquired lactose intolerance may be a sudden change into a milk-based diet. Lactase is an **inducible** enzyme. If milk is withdrawn temporarily, diarrhea will be limited. Curd is also an effective treatment, because the lactobacilli present in curd contains the enzyme lactase. Lactase is abundantly seen in yeast, which could also be used in treatment.

In senior citizens, lactase enzyme may be absent. Normally the adult lactase levels are reached by 6–7 years of age. Adult hypolactasia occurs when lactase expression decreases to 10% of that present in infants. **Secondary lactase deficiency** may result from intestinal diseases that injure the absorptive cells of intestinal villi and decrease lactase activity. The undigested disaccharides, oligosaccharides and dextrins may be hydrolyzed by bacteria and used for their energy needs by converting them to short chain fatty acids (C2–C4) and lactate. Along with this process, gases such as hydrogen, methane and CO_2 are also produced which leads to flatulence. If undigested carbohydrates are left in the intestine, osmotic diarrhea, cramps and flatulence occur.



BOX 8.2 Clinical Application of Absorption of Carbohydrates.

- Common treatment for diarrhea is the intake of oral **rehydration fluid.** It contains glucose and sodium. The presence of glucose in oral rehydration fluid allows the uptake of sodium to replenish body sodium chloride.
- Inhibiting absorption of glucose from intestinal lumen is a therapeutic measure to reduce hyperglycemia (Chapter 9).

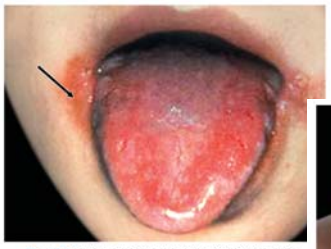
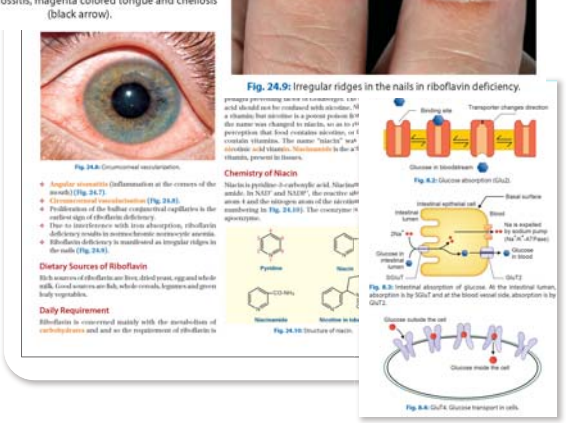


Fig. 24.7: Glossitis, magenta colored tongue and cheilosis (black arrow).

Fig. 24.9: Irregular ridges in the nails in riboflavin deficiency.



Chemistry of Niacin

Dietary Sources of Riboflavin

Daily Requirement

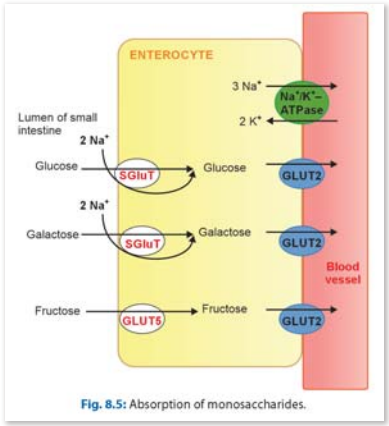


Fig. 8.5: Absorption of monosaccharides.

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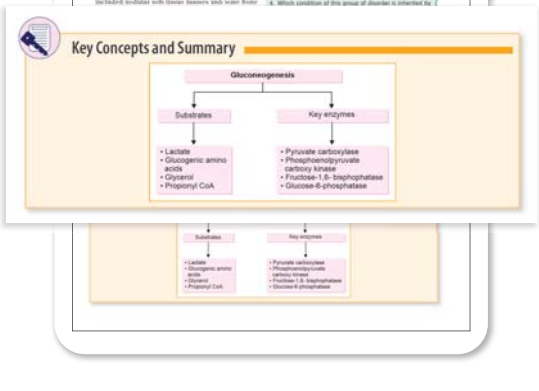
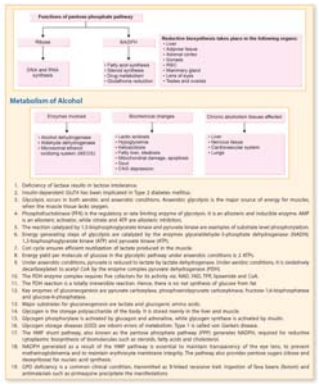
Provides key Concepts and Summaries for effective revision at the end of each chapter.





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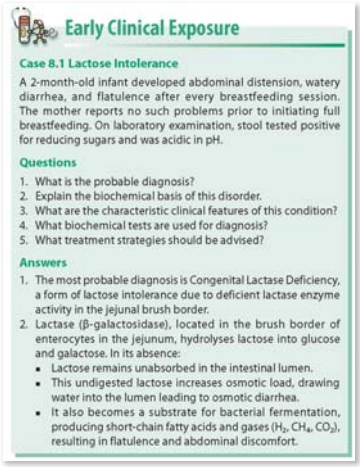

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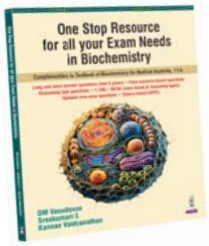

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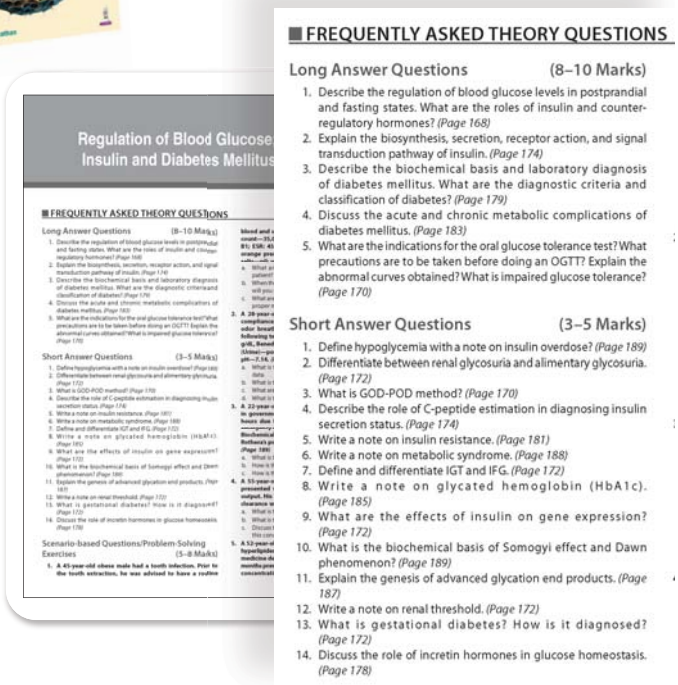


FREQUENTLY ASKED THEORY QUESTIONS

Long Answer Questions (8–10 Marks)

1. Describe the regulation of blood glucose levels in postprandial and fasting states. What are the roles of insulin and counter-regulatory hormones? *(Page 168)*
2. Explain the biosynthesis, secretion, receptor action, and signal transduction pathway of insulin. *(Page 174)*
3. Describe the biochemical basis and laboratory diagnosis of diabetes mellitus. What are the diagnostic criteria and classification of diabetes? *(Page 179)*
4. Discuss the acute and chronic metabolic complications of diabetes mellitus. *(Page 183)*
5. What are the indications for the oral glucose tolerance test? What precautions are to be taken before doing an OGTT? Explain the abnormal curves obtained? What is impaired glucose tolerance? *(Page 170)*

Short Answer Questions (3–5 Marks)

1. Define hypoglycemia with a note on insulin overdose? *(Page 189)*
2. Differentiate between renal glycosuria and alimentary glycosuria. *(Page 172)*
3. What is GOD-POD method? *(Page 170)*
4. Describe the role of C-peptide estimation in diagnosing insulin secretion status. *(Page 174)*
5. Write a note on insulin resistance. *(Page 181)*
6. Write a note on metabolic syndrome. *(Page 188)*
7. Define and differentiate IGT and IFG. *(Page 172)*
8. Write a note on glycated hemoglobin (HbA1c). *(Page 185)*
9. What are the effects of insulin on gene expression? *(Page 172)*
10. What is the biochemical basis of Somogyi effect and Dawn phenomenon? *(Page 189)*
11. Explain the genesis of advanced glycation end products. *(Page 187)*
12. Write a note on renal threshold. *(Page 172)*
13. What is gestational diabetes? How is it diagnosed? *(Page 172)*
14. Discuss the role of incretin hormones in glucose homeostasis. *(Page 178)*

Frequently asked questions, including **Long and Short answer types Questions**, are given at the beginning of the chapters.

Scenarios-based Questions/Problem-Solving Exercises

Scenario-based Questions/Problem-Solving Exercises (5–8 Marks)

1. **A 1-month-old infant presents with bloating, excessive flatulence, and watery diarrhea shortly after feeding. The symptoms worsen when given formula milk. A stool test reveals the presence of reducing sugars, and the pH is found to be acidic.** *(Page 127)*
   a. What is the most likely diagnosis?
   b. What enzyme deficiency causes this condition?
   c. What test can be used to confirm the diagnosis in older children or adults?
   d. What is the treatment and dietary management?
2. **A 14-year-old girl presents with nausea, abdominal pain, rapid breathing, and confusion. Blood gas analysis reveals metabolic acidosis with a high anion gap. Blood lactate level is 7.5 mmol/L (normal <2.0 mmol/L). She has a history of mitochondrial disorder in the family.** *(Page 142)*
   a. What is the most likely diagnosis?
   b. What is the biochemical cause of lactic acidosis?
   c. How do mitochondrial defects contribute to this condition?
   d. What are the main principles in treating lactic acidosis?
3. **A 9-month-old child is brought with complaints of frequent hypoglycemia, irritability, and a protuberant abdomen. Investigations reveal hepatomegaly, hyperuricemia, hyperlipidemia, lactic acidosis, and hypoglycemia.** *(Page 148)*
   a. What is the most likely diagnosis?
   b. What enzyme is deficient?
   c. Explain the biochemical basis for hyperuricemia and lactic acidosis.
   d. What dietary modifications are recommended?
4. **A 3-month-old infant presents with severe muscle weakness, cardiomegaly, and respiratory distress. Enzyme analysis reveals a deficiency of acid alpha-glucosidase.** *(Page 148)*
   a. What is the most likely diagnosis?
   b. What is the biochemical defect involved?
   c. Why is cardiac involvement seen in this condition?
   d. What is the difference between infantile and late-onset forms?

Reasoning Type Questions

REASONING TYPE QUESTIONS

1. Hypoglycemia is more dangerous than hyperglycemia in acute settings. *(Page 170)*
2. Adrenaline increases blood glucose during stress or exercise. *(Page 175)*
3. Cortisol and growth hormone cause hyperglycemia in long-term stress. *(Page 173)*
4. Excess alcohol consumption causes hypoglycemia in fasting individuals. *(Page 181)*
5. C-peptide measurement help differentiate between Type 1 and Type 2 diabetes. *(Page 187)*
6. Sulfonylurea is not effective in Type 1 diabetes. *(Page 187)*
7. OGTT is not routinely used for Type 1 diabetes diagnosis. *(Page 171)*
8. Insulin is injected and not given orally. *(Page 187)*
9. Diabetic ketoacidosis is more common in Type 1 diabetes than Type 2. *(Page 183)*
10. Frequent small meals are advised in patients with reactive hypoglycemia. *(Page 189)*
11. Lactose excreted in urine in a pregnant woman. *(Page 173)*
12. HbA1c is a reliable indicator of long-term glycemic control. *(Page 185)*

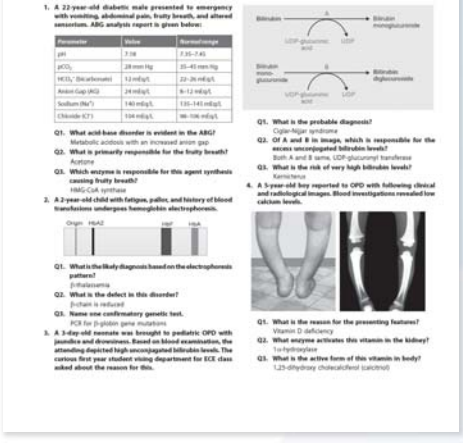
Multiple Choice Questions

MULTIPLE CHOICE QUESTIONS

1. **The main intracellular second messenger for glucagon is:**
   A. cAMP B. cGMP
   C. IP_3 D. DAG
2. **Which of the following insulin actions is mediated by dephosphorylation of enzymes?**
   A. Inhibition of glycogen phosphorylase
   B. Activation of PEPCK
   C. Activation of glucose-6-phosphatase
   D. Suppression of HMG-CoA reductase
3. **C-peptide is useful in diagnosing:**
   A. Starvation ketosis B. Type 2 DM
   C. Insulinoma D. Type 1 DM
4. **Which hormone is secreted in response to food and increases insulin secretion?**
   A. Cortisol B. Epinephrine
   C. GLP-1 D. Glucagon
5. **Mechanism of action of sulfonylureas involves:**
   A. Blocking DPP-4
   B. Activating GLP-1 receptors
   C. Stimulating insulin secretion via SUR
   D. Blocking alpha-glucosidase
6. **Which enzyme does insulin inhibit via gene repression?**
   A. Glucokinase B. Glucose-6-phosphatase
   C. Pyruvate kinase D. Acetyl-CoA carboxylase
7. **Which of the following is a ketone body detectable by Rotheras test?**
   A. Acetyl-CoA B. Acetone
   C. β-Hydroxybutyrate E. Acetoacetate
8. **HbA1c reflects the average glucose level over the past:**
   A. 1–2 days B. 10–12 weeks
   C. 6 months D. 24 hours
9. **Increased methylglyoxal formation in diabetes promotes:**
   A. Insulin secretion B. Glucagon release
   C. AGE formation D. SGLT2 activity
10. **Which hormone contributes to dawn phenomenon in diabetic patients?**
    A. Insulin B. GLP-1
    C. Cortisol D. Somatostatin

Objective Structure Practical Examinations (OSPEs)

Section B
Objective Structure Practical Examinations (OSPEs)

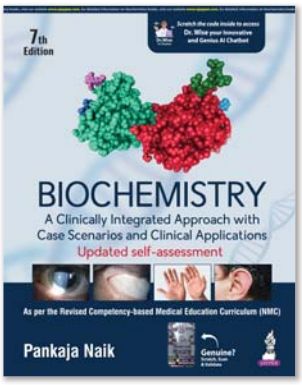


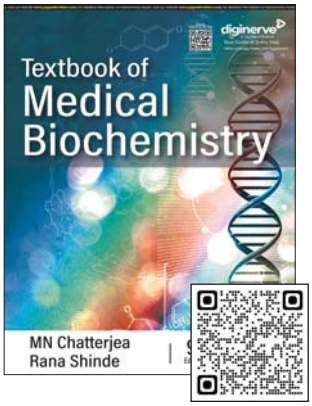
Viva-Voce Questions

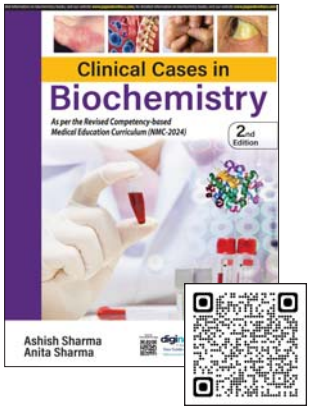
VIVA-VOCE QUESTIONS

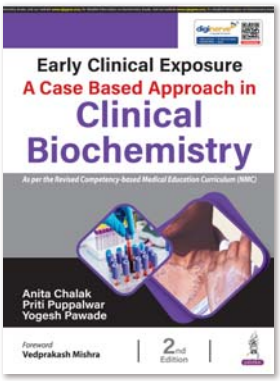
1. **How is glucose absorbed from the intestine?**
   Via sodium-dependent glucose transporter (SGLT) on luminal side.
2. **Which transporter releases glucose from intestinal cells into blood?**
   GLUT2.
3. **What is the role of GLUT4?**
   Insulin-sensitive glucose transporter in muscle and adipose tissue.
4. **How is glucose uptake affected in diabetes mellitus?**
   Reduced GLUT4 leads to impaired glucose entry into muscle cells.
5. **What is glycolysis?**
   Conversion of glucose to pyruvate/lactate with ATP generation.
6. **When is lactate produced instead of pyruvate?**
   Under anaerobic conditions.
7. **What is the significance of glycolysis in RBCs and muscles?**
   It is the only energy source in RBCs; predominant during exercise.
8. **Which enzymes catalyse substrate-level phosphorylation in glycolysis?**
   Phosphoglycerate kinase and pyruvate kinase.

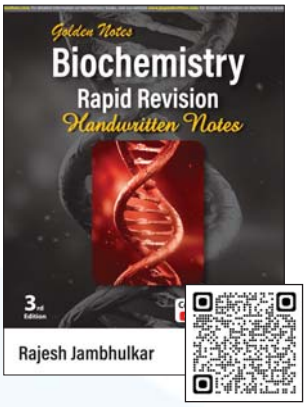
Other Useful Titles

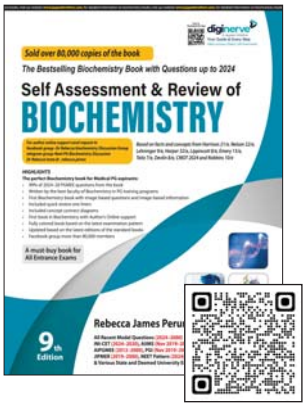


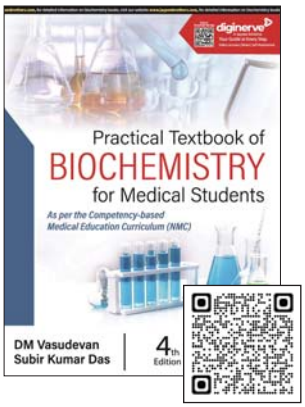


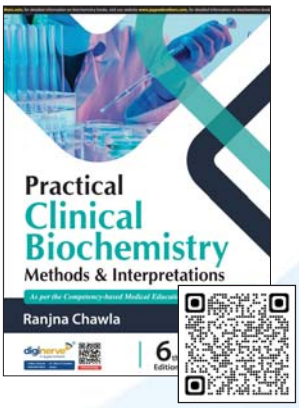


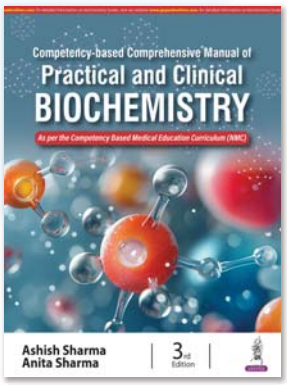


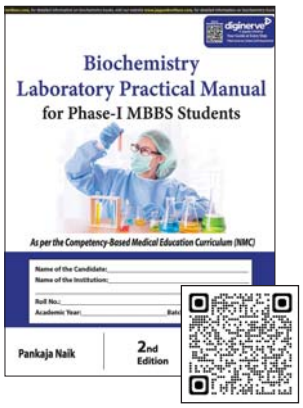


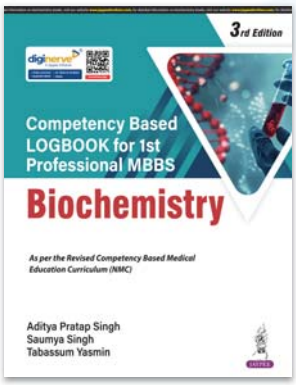












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