Chapter 15:

Biochemistry

Short Questions (Exercise)

1 (i) Give three reasons why living organisms need food.

1. **Energy Source**: Food provides energy for cellular processes and physical activities.
2. **Growth and Repair**: Nutrients help in the growth and repair of tissues.
3. **Regulation of Body Functions**: Vitamins and minerals regulate metabolic and enzymatic activities.
   Example: Carbohydrates like glucose provide quick energy for daily tasks.

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1 (ii) What is a balanced diet? What is the importance of a balanced diet?

- **Balanced Diet**: A diet containing appropriate amounts of macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins, minerals) to meet the body's needs.
- **Importance**:
  - Promotes growth and repair.
  - Strengthens the immune system.
  - Prevents malnutrition and related diseases.
    Example: A balanced diet includes whole grains, lean proteins, fruits, vegetables, and dairy.

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1 (iii) State four functions of proteins. Give one example to illustrate your answer.

1. Build and repair tissues.
2. Act as enzymes to catalyze reactions.
3. Transport molecules (e.g., hemoglobin transports oxygen).
4. Support immune function (e.g., antibodies are proteins).
   Example: Albumin is a protein that regulates blood pressure.

1 (iv) Suggest two major foods a mother could give to her growing child. Why?

1. **Milk**: Rich in calcium and protein for strong bones and growth.
2. **Eggs**: Provide proteins, vitamins, and healthy fats for energy and development.
   Example: Milk helps in bone growth, while eggs support muscle repair.

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1 (v) Carbohydrates are a major source of energy. Defend the statement.

Carbohydrates break down into glucose, which is used by cells to produce ATP, the primary energy carrier. They are quick energy sources, especially during physical activities.
Example: Rice and bread provide sustained energy for daily activities.

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1 (vi) Fatima has fond of junk food like French fries, burgers, and pizza. What will happen if Fatima only eats junk food? What should she add to her routine food?

- **Effect of Junk Food**:
  - Leads to obesity due to high fat and sugar content.
  - Deficiency in essential nutrients causes fatigue and health issues.
- **What to Add**:
  - Fresh fruits and vegetables for vitamins and fiber.
  - Whole grains and lean proteins for balanced nutrition.
    Example: Replace soda with water and include salads for a healthier diet.

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2. What are lipids? How are lipids important to our body?

- **Definition**: Lipids are organic compounds like fats, oils, and cholesterol that are hydrophobic.
- **Importance**:
  - Provide long-term energy storage.
  - Insulate and protect organs.
  - Essential for cell membrane structure and hormone production.
    Example: Omega-3 fatty acids improve brain function and heart health.

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3. How do you maintain a balanced diet?

- Include a variety of foods like whole grains, fruits, vegetables, lean proteins, and dairy.
- Limit intake of processed and sugary foods.
- Stay hydrated and avoid excessive fats or sugars.
  Example: A balanced plate may have grilled chicken, brown rice, and steamed vegetables.

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4. What percentage of fat is required in a balanced diet? Why is the percentage of fat being lowest in major food components? Justify.

- **Recommended Percentage**: 20-35% of total daily calories should come from fat.
- **Reason**: Excess fat leads to weight gain and health problems like heart disease. Carbohydrates are preferred for quick energy, and proteins are essential for repair.
  Example: Avocado provides healthy fats in moderation.

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5. What are the sources and functions of nucleic acids?

- **Sources**: Foods rich in cells, such as meat, fish, eggs, and beans.
- **Functions**:
  - Store genetic information (DNA).
  - Facilitate protein synthesis (RNA).
    Example: DNA in cells determines inherited traits, while RNA helps in protein formation.

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6. Imagine you are a nutritionist tasked to design a meal plan for athletes participating in a marathon. Explain the role of carbohydrates in an athlete's performance during the marathon.

- **Role of Carbohydrates**:
  - Provide quick and sustained energy by breaking down into glucose.
  - Maintain glycogen stores in muscles for endurance activities.
- **Meal Plan**:
  - Pre-race: High-carb foods like pasta or bananas.
  - During the race: Energy gels or sports drinks.
  - Post-race: Recovery foods like sweet potatoes or oatmeal.
    Example: A marathon runner eats pasta the night before to store glycogen for race day.

Extera Short Questions (Topic Wise)

15.1: Nutrition and Healthy Eating

Questions and Answers:

1. **What is the importance of balanced nutrition?**
   Balanced nutrition provides the body with essential nutrients like carbohydrates, proteins, fats, vitamins, and minerals for proper growth and functioning.
   Example: Lack of vitamin C causes scurvy, while excess fat intake leads to obesity.

2. **What are macronutrients?**
   Macronutrients are nutrients required in large amounts by the body, including carbohydrates, proteins, and fats, which provide energy and build tissues.
   Example: Carbohydrates like glucose provide 4 kcal per gram.

3. **Why is water essential for a healthy diet?**
   Water regulates body temperature, aids digestion, and helps in the transport of nutrients and waste products.
   Example: Dehydration leads to fatigue and poor metabolism.

4. **What are the benefits of eating fiber-rich foods?**
   Fiber improves digestion, prevents constipation, and reduces the risk of heart disease by lowering cholesterol levels.
   Example: Whole grains and fruits like apples are high in dietary fiber.

15.2: Biochemical Pathways

Questions and Answers:

1. **What are biochemical pathways?**
   Biochemical pathways are a series of interconnected chemical reactions in cells that convert substrates into products, enabling life processes.
   Example: Glycolysis, the pathway of glucose breakdown to produce energy.

2. **What is the role of ATP in biochemical pathways?**
   ATP (adenosine triphosphate) acts as an energy currency, transferring energy between reactions.
   Example: ATP is generated during cellular respiration to power activities like muscle contraction.

3. **What is the difference between anabolic and catabolic pathways?**
   - **Anabolic Pathways**: Build complex molecules from simpler ones (e.g., protein synthesis).

- **Catabolic Pathways**: Break down molecules to release energy (e.g., glucose breakdown in glycolysis).
  Example: Photosynthesis is anabolic, while respiration is catabolic.

4. **What is glycolysis?**
   Glycolysis is the first step in glucose metabolism, where one glucose molecule is broken into two pyruvate molecules, yielding ATP and NADH.
   Example: Glycolysis occurs in the cytoplasm and generates 2 ATP per glucose molecule.

15.3: Enzymes and Their Functions

Questions and Answers:

1. **What are enzymes?**
   Enzymes are biological catalysts that speed up chemical reactions in the body without being consumed in the reaction.
   Example: Amylase breaks down starch into maltose during digestion.

2. **How do enzymes work?**
   Enzymes bind to substrates at their active site, lower activation energy, and convert substrates into products.
   Example: Lactase breaks lactose into glucose and galactose in the digestive system.

3. **What factors affect enzyme activity?**
   Enzyme activity is influenced by temperature, pH, and substrate concentration.
   Example: Pepsin works best in the acidic pH of the stomach (around pH 2).

4. **What is enzyme specificity?**
   Enzymes are specific, meaning they act on particular substrates due to the unique shape of their active site.
   Example: Sucrase only acts on sucrose and not on other disaccharides.

15.4: Metabolism

Questions and Answers:

1. **What is metabolism?**
   Metabolism is the sum of all chemical reactions in the body that maintain life, including anabolic (building) and catabolic (breaking down) processes.
   Example: Digestion of food to release energy is a metabolic process.

2. **What is the role of metabolism in energy production?**
   Metabolism converts nutrients into energy (ATP) through processes like glycolysis, Krebs cycle, and oxidative phosphorylation.
   Example: Glucose metabolism releases 36-38 ATP molecules.

3. **What is the Krebs cycle?**
   The Krebs cycle is a metabolic pathway in mitochondria that generates ATP, NADH, and $FADH_2$ by oxidizing acetyl-CoA.
   Example: It produces 2 ATP per glucose molecule.

4. **How does metabolism regulate body weight?**
   Metabolic rate determines how efficiently the body burns calories. A higher metabolism burns more calories, while a lower metabolism stores excess as fat.
   Example: Regular exercise boosts metabolism, aiding weight management.

Extera Long Questions (Topic Wise)

1. Explain the Role of Enzymes in Biochemical Pathways

Definition and Importance of Enzymes

Enzymes are biological catalysts that accelerate chemical reactions in cells without being consumed. They are essential for maintaining life processes by lowering the activation energy required for reactions, enabling biochemical pathways to occur efficiently.

How Enzymes Work

1. **Active Site and Substrate Binding:**
   Enzymes have specific active sites where substrates bind, forming an enzyme-substrate complex.
2. **Catalysis**:
   The enzyme facilitates the conversion of substrates into products, which are then released, leaving the enzyme ready for reuse.

Enzyme Specificity

Enzymes are highly specific, meaning each enzyme only works with a particular substrate due to the precise fit of the active site.

Example:
Amylase, an enzyme in saliva, catalyzes the breakdown of starch into maltose during digestion.

Factors Affecting Enzyme Activity

- **Temperature**: Optimal temperature (usually 37°C in humans) enhances enzyme activity, while extreme heat denatures enzymes.
- **pH**: Enzymes work best at specific pH levels, such as pepsin in the acidic environment of the stomach (pH 2).
- **Substrate Concentration**: Increasing substrate concentration enhances activity up to a saturation point.

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2. Describe the Process of Glycolysis and Its Importance in Metabolism

Definition of Glycolysis

Glycolysis is the first step in glucose metabolism, occurring in the cytoplasm of cells. It is an anaerobic process that breaks one molecule of glucose into two molecules of pyruvate, generating ATP and NADH.

Steps of Glycolysis

1. **Energy Investment Phase**:
   Two ATP molecules are consumed to phosphorylate glucose, converting it into fructose-1,6-bisphosphate.

2. **Cleavage Phase**:
   The six-carbon sugar is split into two three-carbon molecules, glyceraldehyde-3-phosphate (G3P).
3. **Energy Payoff Phase**:
   The two G3P molecules are oxidized, producing 4 ATP, 2 NADH, and 2 pyruvate molecules.

Net Energy Yield

- **ATP**: 2 molecules (4 produced - 2 consumed)
- **NADH**: 2 molecules

Example:
During intense exercise, muscles rely on glycolysis for energy in the absence of oxygen.

Importance of Glycolysis

- Produces ATP for immediate energy needs.
- Supplies intermediates for other metabolic pathways, like the Krebs cycle and fermentation.

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3. Discuss the Relationship Between Nutrition and Metabolism

Nutrition as a Foundation for Metabolism

Nutrition provides the raw materials required for metabolic processes. Macronutrients like carbohydrates, proteins, and fats supply energy, while vitamins and minerals act as cofactors for enzymatic reactions.

How Nutrients Support Metabolism

1. **Carbohydrates**:
   Broken down into glucose, carbohydrates are the primary energy source for ATP production.
   Example: Glucose is metabolized in glycolysis to produce energy.
2. **Proteins**:
   Amino acids from proteins are used for building tissues and as precursors in metabolic pathways.
   Example: Glutamine participates in the synthesis of neurotransmitters.
3. **Fats**:
   Fats provide long-term energy storage and are broken down into fatty acids and glycerol for metabolism.
   Example: Fatty acids undergo beta-oxidation to produce acetyl-CoA for the Krebs cycle.

Role of Vitamins and Minerals

- Vitamins like B-complex are essential for energy metabolism.
- Minerals such as iron play a role in oxygen transport and enzyme function.

Impact of Poor Nutrition on Metabolism

- Malnutrition slows metabolic processes, leading to fatigue and reduced immunity.

- Overnutrition causes excess fat storage, increasing the risk of metabolic disorders like diabetes.

Conclusion:
A balanced diet ensures efficient metabolism, supporting energy production, growth, and overall health.

MCQS

15.1: Nutrition and Healthy Eating

1. **What are macronutrients?**
   a) Nutrients required in small amounts
   b) **Nutrients required in large amounts** ✔
   c) Vitamins and minerals
   d) None of the above

2. **Which macronutrient is the main source of energy?**
   a) Proteins
   b) Fats
   c) **Carbohydrates** ✔
   d) Water

3. **What is the role of fiber in a healthy diet?**
   a) Provides energy
   b) Builds muscle
   c) **Improves digestion** ✔
   d) Produces enzymes

4. **Which vitamin deficiency causes scurvy?**
   a) Vitamin A
   b) Vitamin D
   c) **Vitamin C** ✔
   d) Vitamin K

5. **What are micronutrients?**
   a) Carbohydrates and proteins
   b) **Vitamins and minerals** ✔
   c) Fats and water
   d) Sugars and starch

15.2: Biochemical Pathways

6. **What is the role of ATP in cells?**
   a) Stores genetic information
   b) **Transfers energy** ✔
   c) Breaks down waste products
   d) Provides insulation

7. **What is glycolysis?**
   a) The breakdown of proteins
   b) **The breakdown of glucose into pyruvate** ✔

c) The synthesis of fatty acids
d) The production of enzymes

8. **What is an anabolic pathway?**
   a) Breaks down molecules to release energy
   b) **Builds complex molecules from simpler ones** ✔
   c) Involves only fats
   d) Causes muscle fatigue

9. **What is the Krebs cycle?**
   a) A pathway for protein synthesis
   b) **A metabolic pathway in mitochondria for energy production** ✔
   c) A method to digest food
   d) A process to remove toxins

10. **What are the end products of glycolysis?**
    a) Glucose and oxygen
    b) ATP and water
    c) **Pyruvate, ATP, and NADH** ✔
    d) Amino acids

15.3: Enzymes and Their Functions

11. **What are enzymes?**
    a) Proteins that speed up chemical reactions ✔
    b) Carbohydrates used for energy
    c) Vitamins that build tissues
    d) Minerals that strengthen bones

12. **What is the active site of an enzyme?**
    a) The part of the enzyme that stores energy
    b) **The part of the enzyme where the substrate binds** ✔
    c) The part that transports molecules
    d) The part that breaks down ATP

13. **What happens to enzymes at very high temperatures?**
    a) Their activity increases
    b) **They get denatured and lose function** ✔
    c) They become more reactive
    d) They work faster

14. **What is enzyme specificity?**
    a) Enzymes react with any molecule
    b) **Enzymes only react with specific substrates** ✔
    c) Enzymes work in all pH levels
    d) Enzymes do not require a substrate

15. **What factors affect enzyme activity?**
    a) Temperature and pH ✔

b) Substrate concentration only
c) Substrate shape only
d) None of the above

15.4: Metabolism

16. **What is metabolism?**
    a) The study of nutrients
    b) The storage of ATP
    c) **The sum of all chemical reactions in the body** ✔
    d) The process of breathing

17. **What is catabolism?**
    a) The synthesis of complex molecules
    b) The production of energy
    c) **The breakdown of molecules to release energy** ✔
    d) The storage of fat

18. **What is the role of the Krebs cycle in metabolism?**
    a) Produces energy in the form of ATP ✔
    b) Synthesizes proteins
    c) Converts water into energy
    d) Breaks down DNA

19. **Which molecule is the main energy carrier in metabolism?**
    a) DNA
    b) RNA
    c) **ATP** ✔
    d) Lipids

20. **What is the difference between anabolic and catabolic pathways?**
    a) Both break down molecules
    b) Both build molecules
    c) **Anabolic pathways build molecules, catabolic pathways break them down** ✔
    d) They are identical processes

General Biochemistry

21. **What is the function of proteins in the body?**
    a) Energy storage
    b) **Build and repair tissues** ✔
    c) Transport oxygen
    d) Store vitamins

22. **What are lipids?**
    a) Proteins used for muscle building
    b) Sugars used for energy

c) **Fats and oils used for long-term energy storage** ✔
d) Vitamins that protect cells

23. **Which process occurs in the mitochondria?**
a) Protein synthesis
b) DNA replication
c) **Krebs cycle and oxidative phosphorylation** ✔
d) Glycolysis

24. **What is the main function of carbohydrates?**
a) Build tissues
b) **Provide energy** ✔
c) Store water
d) Act as enzymes

25. **What are cofactors?**
a) Proteins that act as enzymes
b) **Non-protein molecules required for enzyme activity** ✔
c) Carbohydrates that provide energy
d) Fats used for insulation

Advanced Biochemistry

26. **What happens in oxidative phosphorylation?**
a) ATP is broken down
b) **ATP is synthesized using energy from electrons** ✔
c) Glucose is converted into pyruvate
d) Proteins are broken into amino acids

27. **Which pathway produces the most ATP?**
a) Glycolysis
b) **Electron Transport Chain** ✔
c) Krebs cycle
d) Photosynthesis

28. **What is the role of NADH and $FADH_2$ in metabolism?**
a) Store energy directly
b) **Transfer electrons to the electron transport chain** ✔
c) Break down molecules
d) Build proteins

29. **What is the end product of protein metabolism?**
a) Glucose
b) Lipids
c) **Amino acids** ✔
d) Fatty acids

30. **Which organ plays a major role in metabolism?**
a) Heart

b) **Liver** ✓
c) Kidneys
d) Brain