

# Competency Based Questions and Answers in **Biochemistry**

*for First MBBS Professional Examination*

Compiled and designed as per  
Competency Based Undergraduate Curriculum for the Indian Medical Graduate  
prescribed by Medical Council of India


- 36 Long Essays
- 159 Short Essays
- 175 Short Notes
- 600 MCQs

**Sushrutha Academy**



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Bengaluru**



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to

*Ancient Gurus of Bharat*







## Preface

*“Assessment drives learning”*

The purpose of assessment is not just to assess learning but also assist learning. The new CBME curriculum proposed by the Medical Council of India (MCI) calls for an outcome-based teaching-learning approach and transition from just acquisition of knowledge to application and practice of knowledge. Assessments need to be designed to suit the newer teaching-learning methods and to assess if the required competency has been achieved or not.

The purpose of bringing out this book is to introduce the I MBBS students to the new format of questions that are most likely to be asked during the internal assessment and the university examination and also equip them to face these examinations without fear. Students can use this book for self-assessment of learning, preparing for internal assessment and university examination.

The book has been compiled by group of teachers who have undergone MCI recognized training in revised basic medical education technologies and advanced course in medical education. The questions in this book have been arranged according to competencies as listed in the MCI curriculum document. Various types of questions including structured long essays, modified essays, short answers, and multiple choice questions are added. These questions have been framed according to the guidelines set by the MCI with appropriate use of verbs at each level of Bloom's taxonomy of cognitive domain. The questions not only assess recall but also higher levels of learning.

We would like to acknowledge all the people who are involved in the publishing of this book especially Shri SK Jain (Chairman), Shri Varun Jain (Director), Mr YN Arjuna (Vice President—Publishing, Editorial and Publicity), Mrs Ritu Chawla (General Manager) and Mrs Jassi of CBS Publishers & Distributors, for their all-time support.

We hereby wish all the readers of the book all the best in their endeavors.

Happy reading!

**Sushrutha Academy**

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## Details of the Number of Questions and MCQs included as per the Competency

S. No.	Competency No.	Competency Details	Long Essays	Short Essays	Short Notes	MCQs
<b>1. Basic Biochemistry</b>						
1.	BI 1.1	Describe the molecular and functional organization of a cell and its sub-cellular components	—	04	02	08
<b>2. Enzyme</b>						
2.	BI 2.1	Explain fundamental concepts of enzyme, isoenzyme, alloenzyme, coenzyme and co-factors. Enumerate the main classes of IUBMB nomenclature	03	05	05	08
3.	BI 2.2	Observe the estimation of SGOT and SGPT	—	02	02	13
4.	BI 11.13	Demonstrate the estimation of SGOT/SGPT	—	02	01	07
5.	BI 2.3	Describe and explain the basic principles of enzyme activity	—	02	01	07
6.	BI 2.4	Describe and discuss enzyme inhibitors as poisons and drugs and as therapeutic enzymes	01	02	01	06
7.	BI 2.5	Describe and discuss the clinical utility of various serum enzymes as markers of pathological conditions	01	02	04	10
	BI 2.7	Interpret laboratory results of enzymes activities and describe the clinical utility of various enzymes as markers of pathological conditions	—	02	—	05
8.	BI 2.6	Discuss use of enzymes in laboratory investigations (enzyme-based essays)	—	02	—	05
<b>3. Chemistry and Metabolism of Carbohydrates</b>						
8.	BI 3.1	Discuss and differentiate monosaccharides, di-saccharides and polysaccharides giving examples of main carbohydrates as energy fuel, structural element and storage in the human body	—	01	05	06
9.	BI 3.2	Describe the processes involved in digestion and assimilation of carbohydrates and storage	—	02	01	05
	BI 3.3	Describe and discuss the digestion and assimilation of carbohydrates from food	—	02	01	05

S. No.	Competency No.	Competency Details	Long Essays	Short Essays	Short Notes	MCQs
10.	BI 3.4	Define and differentiate the pathways of carbohydrate metabolism (glycolysis, gluconeogenesis, glycogen metabolism, HMP shunt)	04	06	03	05
11.	BI 3.5	Describe and discuss the regulation, functions and integration of carbohydrate along with associated diseases/disorders	—	—	01	09
12.	BI 3.6	Describe and discuss the concept of TCA cycle as an amphibolic pathway and its regulation	01	02	—	06
13.	BI 3.7 BI 3.8	Describe the common poisons that inhibit crucial enzymes of carbohydrate metabolism (e.g. fluoride, arsenate) Discuss and interpret laboratory results of analytes associated with metabolism of carbohydrates	—	02	—	13
14.	BI 3.9 BI 3.10	Discuss the mechanism and significance of blood glucose regulation in health and disease Interpret the results of blood glucose levels and other laboratory investigations related to disorders of carbohydrate metabolism	01	02	03	09
<b>4. Chemistry and Metabolism of Lipids</b>						
15.	BI 4.1	Describe and discuss main classes of lipids (essential/non-essential fatty acids, cholesterol and hormonal steroids, triglycerides, major phospholipids and sphingolipids) relevant to human system and their major functions	—	05	05	07
16.	BI 4.2	Describe the processes involved in digestion and absorption of dietary lipids and also the key features of their metabolism	01	10	—	05
17.	BI 4.3	Explain the regulation of lipoprotein metabolism and associated disorders	01	02	02	05
18.	BI 4.4	Describe the structure and functions of lipoproteins, their functions, interrelations and relations with atherosclerosis	—	07	02	06
19.	BI 4.5 BI 4.7	Interpret laboratory results of analytes associated with metabolism of lipids	02	03	01	08
20.	BI 4.6	Describe the therapeutic uses of prostaglandins and inhibitors of eicosanoid synthesis	—	01	01	05
<b>5. Chemistry and Metabolism of Proteins</b>						
21.	BI 5.1	Describe and discuss structural organization of proteins	—	02	07	11
22.	BI 5.2	Describe and discuss functions of proteins and structure—function relationships in relevant areas, e.g. hemoglobin and selected hemoglobinopathies	—	03	02	06

S. No.	Competency No.	Competency Details	Long Essays	Short Essays	Short Notes	MCQs
23.	BI 5.3	Describe the digestion and absorption of dietary proteins	—	02	02	05
24.	BI 5.4	Describe common disorders associated with protein metabolism	03	09	15	07
25.	BI 5.5	Interpret laboratory results of analytes associated with metabolism of proteins	01	03	01	05
<b>6. Metabolism and Homeostasis</b>						
26.	BI 6.1	Discuss the metabolic processes that take place in specific organs in the body in the fed and fasting states	—	04	—	08
27.	BI 6.2 BI 6.3	Describe and discuss the metabolic processes in which nucleotides are involved Describe the common disorders associated with nucleotide metabolism	01	03	—	14
28.	BI 6.4	Discuss the laboratory results of analytes associated with gout and Lesch-Nyhan syndrome	—	02	—	09
29.	BI 6.5	Describe the biochemical role of vitamins in the body and explain the manifestations of their deficiency	04	08	07	09
30.	BI 6.6	Describe the biochemical processes involved in generation of energy in cells	—	03	—	10
31.	BI 6.7	Describe the processes involved in maintenance of normal pH, water and electrolyte balance of body fluids and the derangements associated with these	—	04	06	07
32.	BI 6.8	Discuss and interpret results of Arterial blood gas (ABG) analysis in various disorders	01	02	02	08
33.	BI 6.9	Describe the functions of various minerals in the body, their metabolism and homeostasis	—	02	04	07
34.	BI 6.10	Enumerate and describe the disorders associated with mineral metabolism	01	02	—	05
35.	BI 6.11	Describe the functions of haem in the body and describe the processes involved in its metabolism and describe porphyrin metabolism	01	03	—	09
36.	BI 6.12	Describe the major types of hemoglobin and its derivatives found in the body and their physiological/pathological relevance	—	02	—	06
37.	BI 6.13	Describe the functions of the kidney, liver, thyroid and adrenal glands	—	03	—	05
38.	BI 6.14	Describe the tests that are commonly done in clinical practice to assess the functions of these organs (kidney, liver, thyroid and adrenal glands)	01	03	—	11
39.	BI 6.15	Describe the abnormalities of kidney, liver, thyroid and adrenal glands	01	01	01	06

S. No.	Competency No.	Competency Details	Long Essays	Short Essays	Short Notes	MCQs
<b>7. Molecular Biology</b>						
40.	BI 7.1	Describe the structure and functions of DNA and RNA and outline the cell cycle	—	03	05	08
41.	BI 7.2	Describe the processes involved in replication and repair of DNA and the transcription and translation mechanisms	03	04	14	08
42.	BI 7.3	Describe gene mutations and basic mechanism of regulation of gene expression	—	03	02	09
43.	BI 7.4	Describe applications of molecular technologies like recombinant DNA technology, PCR in the diagnosis and treatment of diseases with genetic basis	01	04	04	07
44.	BI 7.5	Describe the role of xenobiotics in disease	—	03	03	09
45.	BI 7.6	Describe the anti-oxidant defence systems in the body	—	01	03	08
46.	BI 7.7	Describe the role of oxidative stress in the pathogenesis of conditions such as cancer, complications of diabetes mellitus and atherosclerosis	—	—	02	05
<b>8. Nutrition</b>						
47.	BI 8.1	Discuss the importance of various dietary components and explain importance of dietary fibre	—	01	04	07
48.	BI 8.2	Describe the types and causes of protein energy malnutrition and its effects	—	01	01	06
49.	BI 8.3	Provide dietary advice for optimal health in childhood and adult, in disease conditions like diabetes mellitus, coronary artery disease and in pregnancy	01	—	01	06
50.	BI 8.4	Describe the causes (including dietary habits), effects and health risks associated with being overweight/obesity	—	—	02	07
51.	BI 8.5	Summarize the nutritional importance of commonly used items of food including fruits and vegetables (macromolecules and its importance)	—	—	05	05
<b>9. Extracellular Matrix</b>						
52.	BI 9.1	List the functions and components of the extracellular matrix (ECM)	—	—	02	04
53.	BI 9.2	Discuss the involvement of ECM components in health and disease	—	03	—	08
54.	BI 9.3	Describe protein targeting and sorting along with its associated disorders	—	01	—	10
<b>10. Oncogenesis and Immunity</b>						
55.	BI 10.1	Describe the cancer initiation, promotion oncogenes and oncogene activation. Also focus on p53 and apoptosis	01	—	03	15



S. No.	Competency No.	Competency Details	Long Essays	Short Essays	Short Notes	MCQs
56.	BI 10.2	Describe various biochemical tumor markers and the biochemical basis of cancer therapy	01	03	02	06
57.	BI 10.3	Describe the cellular and humoral components of the immune system and describe the types and structure of antibody	—	02	02	07
58.	BI 10.4	Describe and discuss innate and adaptive immune responses, self/non-self recognition and the central role of T-helper cells in immune responses	—	01	—	06
59.	BI 10.5	Describe antigens and concepts involved in vaccine development	—	01	01	05
<b>11. Biochemical Laboratory Test</b>						
60.	BI 11.1	Describe commonly used laboratory apparatus and equipment, good safe laboratory practice and waste disposal	—	—	01	08
61.	BI 11.2	Describe the preparation of buffers and estimation of pH	—	—	01	04
62.	BI 11.3	Describe the chemical components of normal urine	—	—	01	06
63.	BI 11.4	Perform urine analysis to estimate and determine normal and abnormal constituents	—	—	03	08
64.	BI 11.5	Describe screening of urine for inborn errors and describe the use of paper chromatography	—	—	03	11
65.	BI 11.6	Describe the principles of colorimetry	—	—	01	05
66.	BI 11.7	Demonstrate the estimation of serum creatinine and creatinine clearance	—	—	01	07
67.	BI 11.8	Demonstrate estimation of serum proteins, albumin and A:G ratio	—	—	01	07
68.	BI 11.9	Demonstrate the estimation of serum total cholesterol and HDL cholesterol	—	—	01	06
69.	BI 11.10	Demonstrate the estimation of triglycerides	—	—	01	05
70.	BI 11.11	Demonstrate estimation of calcium and phosphorus	—	—	01	05
71.	BI 11.12	Demonstrate the estimation of serum bilirubin	—	—	01	05
72.	BI 11.14	Demonstrate the estimation of alkaline phosphatase	—	—	01	05
73.	BI 11.15	Describe and discuss the composition of CSF	—	—	02	12
74.	BI 11.16	Observe use of commonly used equipment/ techniques in biochemistry laboratory including: <ul style="list-style-type: none"> <li>• pH meter</li> <li>• Paper chromatography of amino acid</li> <li>• Protein electrophoresis</li> <li>• TLC, PAGE</li> <li>• Electrolyte analysis by ISE</li> <li>• ABG analyzer</li> <li>• ELISA</li> </ul>	—	—	06	09

S. No.	Competency No.	Competency Details	Long Essays	Short Essays	Short Notes	MCQs
75.	BI 11.17	<ul style="list-style-type: none"> <li>• Immunodiffusion</li> <li>• Autoanalyzer</li> <li>• Quality control</li> <li>• DNA isolation from blood/tissue</li> </ul> Explain the basis and rationale of biochemical tests done in the following conditions: <ul style="list-style-type: none"> <li>• Diabetes mellitus</li> <li>• Dyslipidemia</li> <li>• Myocardial infarction</li> <li>• Renal failure, gout</li> <li>• Proteinuria</li> <li>• Nephrotic syndrome</li> <li>• Edema</li> <li>• Jaundice</li> <li>• Liver diseases, pancreatitis, disorders of acid-base balance</li> <li>• Thyroid disorders</li> </ul>	Addressed in various competencies			12
76.	BI 11.18	Discuss the principles of spectrophotometry	—	—	01	04
77.	BI 11.19	Outline the basic principles involved in the functioning of instruments commonly used in a biochemistry laboratory and their applications	Addressed in various competencies			07
78.	BI 11.20	Identify abnormal constituents in urine, interpret the findings and correlate these with pathological states	—	—	01	07
	BI 11.21	Demonstrate estimation of glucose, creatinine, urea and total protein in serum	—	—	01	06
79.	BI 11.22	Calculate albumin:globulin (AG) ratio and creatinine clearance	—	—	02	05
80.	BI 11.23	Calculate energy content of different food items. Identify food items with high and low glycemic index and explain the importance of these in the diet	—	03	02	08
81.	BI 11.24	Enumerate advantages and/or disadvantages of use of unsaturated, saturated and and trans fats in food	—	02	01	08
<b>Total Content</b>			<b>36</b>	<b>159</b>	<b>175</b>	<b>600</b>

## Basic Biochemistry

### BI 1.1 Describe the molecular and functional organization of a cell and its sub-cellular components

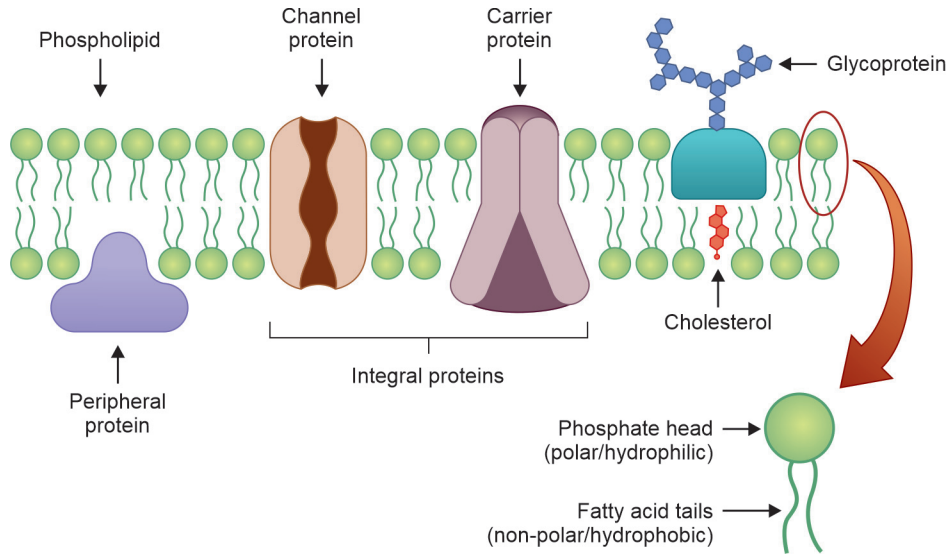
#### SHORT ESSAYS

**1. Explain the structure of plasma membrane with a neat labelled diagram and describe its function. (3 + 2 marks)**

- A semipermeable membrane that allows the passage of only specific constituents owing to their highly selective semipermeable nature
- The following are the main constituents of the membrane
  - ♦ Proteins
  - ♦ Lipids
  - ♦ Cholesterol
  - ♦ Carbohydrates (in small amounts)
- The contents of these components vary according to nature of the membrane.

#### Structure

- *Most widely accepted structural model:* Fluid mosaic model (Singer and Nicolson).
- The following are the salient features:
  - ♦ Arrangement of phospholipids in bilayers: Hydrophilic polar groups facing the cytoplasmic and extracellular side, and the hydrophobic (non-polar) groups forming the core
  - ♦ Distribution in such a way that choline containing phospholipids are arranged in the external layer and ethanolamine and serine containing phospholipids are mostly in the inner layer.
  - ♦ Total thickness is about 5–8 nm
  - ♦ Surface of the bilayer has peripheral proteins that are attached to the hydrophilic head by ionic and polar bonds
  - ♦ Integral proteins are deeply embedded in the bilayer and are attached by hydrophobic bonds or van der Waals forces. If the integral proteins span the entire length of the bilayer, it is called a transmembrane protein.



### Functions of the Cell Membrane

1. Provides support and shape to the cell
2. Allows only specific molecules to pass through semipermeability
3. Membrane proteins are integral to functions such as signal transmission.
4. Aids in exocytosis and endocytosis

### 2. Classify the transport mechanisms across the membrane. Describe the characteristics of facilitated diffusion with example. (2 + 3 marks)

- Transport mechanisms across the membrane are classified into:
  1. Passive transport
  2. Active transport.

#### Passive Transport

- Further subclassified into simple diffusion, facilitated diffusion, ion channels
- It is driven by concentration gradient
- Does not require energy.

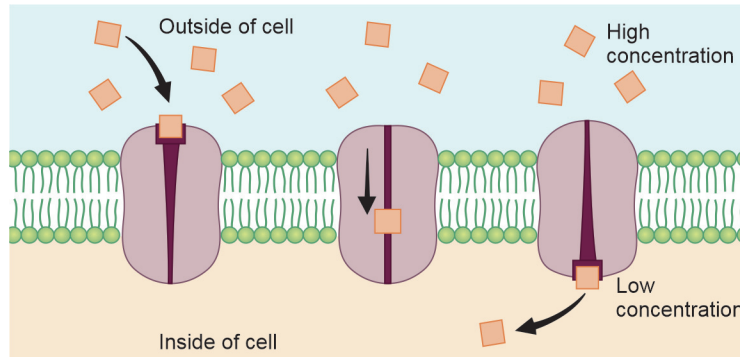
#### Active Transport

- This required energy
- Unidirectional
- Requires integral proteins called transporters
- Transporters saturated at higher concentrations.

#### Facilitated Diffusion

- It is a carrier mediated process
- Carrier mechanism is saturable
- Competitive inhibition of structurally similar solutes, thus entry into the cells are inhibited
- It can operate in both directions (bidirectional)
- Facilitated diffusion does not require energy, the rate of transport across the membrane is more rapid than simple diffusion.

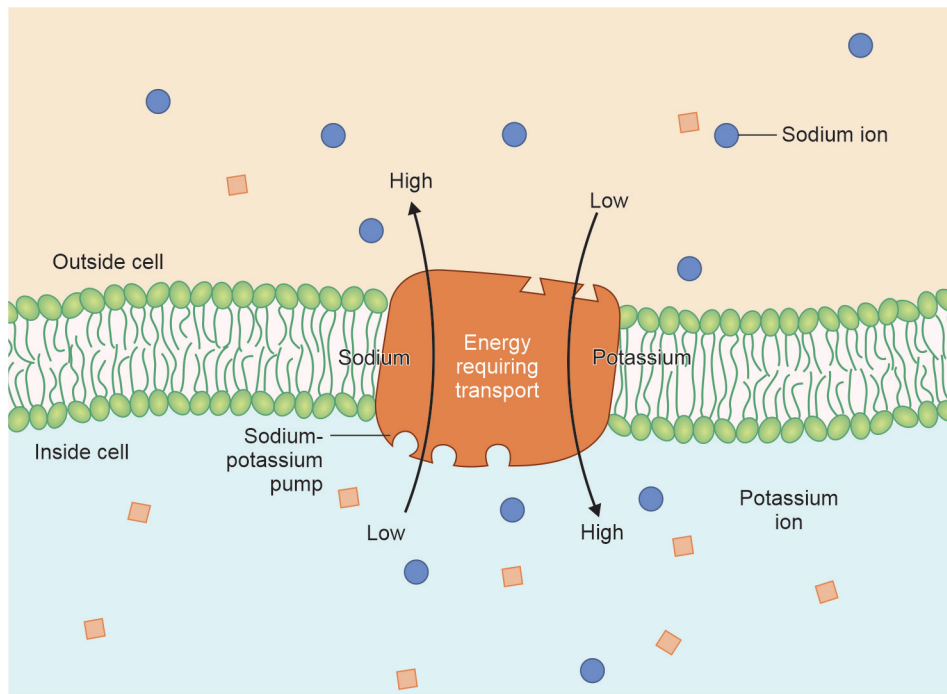
- It can exist in two conformations: Ping and pong states.
  1. In the ping state, the active cases are facing the interior of the cell, where the concentration of the solute is minimal.
  2. In the pong state, the active sites are exposed to the exterior when the solutes bind to the specific sites.



### 3. Explain primary and secondary active transport with suitable examples.

#### Primary Active Transport

- The transport molecules across a membrane against their concentration gradient utilizing the energy directly in the form of ATP.
- Examples: Sodium-potassium ATPase, calcium ATPase,  $H^+/K^+-ATPase$

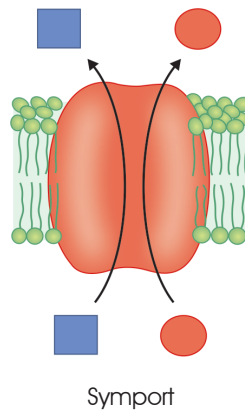


### Secondary Active Transport

- Transport of molecules across the cell membrane utilizing energy indirectly in the form of ATP
- This energy usually comes from the electrochemical gradient created by pumping ions out of the cell
- There are two types:
  1. Symport
  2. Antiport

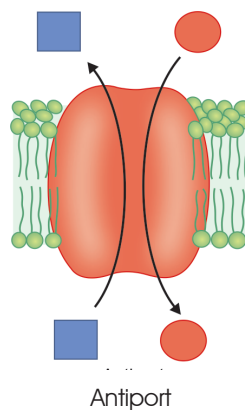
#### Symport

- Ions move in same direction
- One ion traps the other and takes it along in same direction.
- Examples:
  1. Sodium-glucose cotransport
  2. Sodium-amino acid cotransport



#### Antiport

- Ions move in opposite direction.
- Examples
  1.  $\text{Na}^+/\text{Ca}^{2+}$  counter transport
  2.  $\text{Na}^+/\text{H}^+$  counter transport



#### 4. Mention the functions and clinical disorders associated with peroxisomes.

##### Functions of Peroxisomes

Catalase and peroxidase are antioxidant enzymes present in peroxisomes destroy the unwanted reactive oxygen species or free radicals.

##### Clinical Disorders Associated with Peroxisome

1. *Adrenal leukodystrophy*: An autosomal recessive condition, due to deficiency of peroxisomal matrix protein. Oxidation of very long chain fatty acids by peroxisomes are insufficient, leading to degeneration of liver, kidney and brain.
2. *Zellweger syndrome*: Formation of empty peroxisomes as proteins are not transported into peroxisomes.
3. *Primary hyperoxaluria*: Defective peroxisomal metabolism of glyoxylate.

#### SHORT NOTES

#### 1. Mention the functions and clinical disorder associated with lysosomes.

Lysosomes secrete the hydrolytic enzymes of carbohydrate, proteins, lipids and nucleotides thus help in degradation. The lysosomal enzymes have optimal pH of 5 for its functioning.

##### Clinical Disorders

- *Gout*: Deposition of urate crystals around knee joints. These when gets phagocytosed cause physical damage to lysosomes and the enzymes present in lysosomes are released into the surrounding. These hydrolyzing enzymes cause inflammation and arthritis.
- *Postmortem autolysis*: After cell death, the lysosomes rupture releasing the hydrolytic enzymes, these enzymes destroy the cells resulting in postmortem autolysis.
- *Silicosis* results from inhalation of silica particles. Inside the cell silica particles are taken up by phagocytes. Lysosomal enzymes are released stimulates fibroblast to proliferate and deposit collagen fibers, resulting in fibrosis and decreased elasticity of lungs.

#### 2. Describe peroxisomal disorders.

- *Adrenal leukodystrophy*: An autosomal recessive condition, due to deficiency of peroxisomal matrix protein. Insufficient oxidation of very long chain fatty acids by peroxisomes, leading to degeneration of liver, kidney and brain.
- *Zellweger syndrome*: Formation of empty peroxisomes as proteins are not transported into peroxisomes.
- *Primary hyperoxaluria*: Defective peroxisomal metabolism of glyoxylate.