CHAPTER › 12

Mineral Nutrition

NEET KEY NOTES

- **Mineral nutrients** are the various inorganic substances or minerals which provide nourishment to living organisms or raw materials for building the body structure and maintaining its normal functions are called mineral nutrients.
- **Mineral nutrition** is the mode of intake of all required nutrients by plants. Plants generally derive their inorganic nutrients from soil, water and atmosphere while, the organic nutrients are the products of photosynthesis.

Methods to Study the Mineral Requirements of Plants

- The German botanist **Julius von Sachs** in 1980 demonstrated for the first time that plants could be grown to maturity in a well-defined nutrient solution in the complete absence of soil.
- This technique of growing plants in a soil-free nutrient solution is known as **hydroponics**.
- This technique is used to identify essential elements required for the plant growth as well as their deficiency symptoms. It is also used for the commercial production of vegetables such as tomato, seedless cucumber and lettuce.

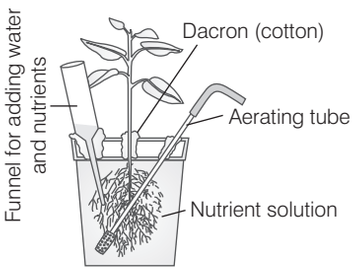


Diagram of a typical setup of nutrient solution culture

Essential Mineral Nutrients (Elements)

- Essential mineral elements are those elements which have structural or physiological role and are absolutely necessary for plants to complete their life cycle.
- An element is considered essential, if it follows the given criteria
  - Element must be absolutely necessary to support the normal growth and reproduction of plants.
  - Requirement of the element must be specific and not replaceable by another element.
  - The element must be directly involved in the metabolism of the plant.

Classification of Essential Elements

- Plants require 17 essential elements, which are C, H, O, N, P, K, S, Mg, Ca, Fe, B, Mn, Cu, Zn, Mo, Cl and Ni.
- On the basis of the amount of elements required by plants, these inorganic nutrients are broadly categorised into two categories, which are

I. **Macronutrients**
  - Generally present in plant tissues in large amount (in excess of 10 m mole kg^{-1} of dry matter).
  - Involved in synthesis of organic molecules and do not become toxic in slight excess.
  - Include carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, potassium, calcium and magnesium.
  - Carbon, hydrogen and oxygen are obtained from CO_2 and H_2O, while others are absorbed from soil.

II. **Micronutrients**
  - Trace elements, needed in small amount (less than 10 m mole kg^{-1} of dry matter).

- Involved in functioning of enzymes and become toxic in slight excess.
- Include iron, manganese, copper, molybdenum, zinc, boron, chlorine and nickel.

- On the basis of their diverse function, the mineral nutrients can also be categorised as follows
  - Structural elements which include components of biomolecules (e.g. C, H, O and N).
  - Energy related compounds include components of energy related chemical compound in plants (e.g. Mg in chlorophyll and P in ATP).
  - Activators of enzyme constitute elements that activate or inhibit enzymes (e.g. Mg^{2+} is an activator of RuBisCO enzyme).
  - Maintenance of osmotic potential of cell includes elements that alter osmotic potential of a cell (e.g. potassium).

Mineral Nutrients, their Functions and Deficiency Symptoms

Mineral Elements	Obtained as	Functions	Deficiency symptoms
Nitrogen	NO_3^-, NO_2^-, NH_4^{2-}	• Constituent of proteins, nucleic acids, vitamins and hormones.	• Chlorosis, premature leaf fall
Phosphorus	$H_2PO_4^-$, $H_2PO_4^{2-}$	• Constituent of cell membranes, proteins, nucleic acids and nucleotides. Required for all phosphorylation reactions.	• Delay in seed germination. • Purple spots on older leaves. • Premature leaf fall.
Magnesium	Mg^{2+}	• Activates enzymes of respiration and photosynthesis. • Involved in synthesis of DNA and RNA. • Constituents of the ring structure of chlorophyll. • Maintains ribosome structure.	• Chlorosis and necrosis
Calcium	Ca^{2+}	• During cell division used in synthesis of cell wall. • Formation of mitotic spindle. • Normal functioning of cell membranes. • Regulates metabolic activities.	• Necrosis of young meristematic regions. • Stunted growth.
Potassium	K^+	• Maintains ionic balance, involved in protein synthesis, activations of enzymes, opening and closing of stomata, maintains turgidity of cell.	• Scorched leaf tips. • Loss of cambial activity loss of apical dominance.
Sulphur	SO_4^{2-} (Sulphate)	• Presents in two amino acids, i.e. cysteine and methionine. • Main constituents of several coenzymes, vitamins and ferredoxin.	• Chlorosis, stunted growth. • Anthocyanin accumulation.
Iron	Fe^{3+} (Ferric ions)	• Constituent of proteins involved in transfer of electrons like ferredoxin and cytochromes. • Activates catalase enzyme. • Formations of chlorophyll.	• Interveinal chlorosis
Manganese	Mn^{2+} (Manganous ions)	• Activates enzyme involved in photosynthesis, respiration and nitrogen metabolism. • Splitting of water to liberate oxygen during photosynthesis.	• Chlorosis • Grey spots on leaves
Zinc	Zn^{2+}	• Activates various enzymes especially carboxylases. • Synthesis of auxin.	• Chlorosis • Leaf malformation
Copper	Cu^{2+} (Cupric ions)	• Overall metabolism. • Associated with certain enzymes involved in redox reactions.	• Necrosis of tips of leaves. • Dieback of shoots.
Boron	BO_3^{3-}, $B_4O_7^{2-}$	• Uptake and utilisation of Ca^{2+}. • Membrane functioning. • Pollen germination • Cell elongation and differentiation. • Carbohydrate metabolism.	• Premature leaf abscission, stunted growth. • Disintegration of internal leaves.
Molybdenum	MoO_2^{2-} (Molybdate ions)	• Component of several enzymes including nitrogenase and nitrate reductase.	• Defective nitrogen metabolism. • Chlorosis.
Chlorine	Cl^- (Chloride anion)	• Helps in determining the solute concentration. • Maintains ionic balance. • Essentials for water splitting reaction in photosynthesis.	• Wilting of leaves, chlorosis, necrosis.

Deficiency Symptoms of Essential Elements

- The concentration of the essential elements below which plant growth is retarded is termed as **critical concentration**. An element is said to be deficient if it is present below its critical concentration. The plants show certain morphological changes if an essential element is deficient which are indicative of their deficiency and are called **deficiency symptoms**.
- The elements which cannot move freely in the plants are called immobile elements, e.g. Ca, B, S and Fe.
- The elements which can move from old leaves to young leaves and growing tips are called mobile elements, e.g. N, P, Cl and Mg.
- Deficiency symptoms of immobile elements first appear in young leaves and that of mobile elements appear initially in old leaves.

Toxicity of Micronutrients

Absorption of minerals in a slightly higher amount causes mineral toxicity in plants. Any mineral ion concentration in tissues that reduce the dry weight of tissues by about 10% is considered toxic. The toxicity of one mineral may induce deficiency of other minerals, e.g. Mn toxicity results in deficiency of Fe, Mg and Ca.

Mechanism of Absorption of Elements

- Minerals can be absorbed in ionic form only and the most important areas for mineral absorption are the elongation zone and root hair zone. Mineral absorption by plants is done in two different phases
  - **The first phase** involves passive absorption of mineral ions in the outer free space of cell in the apoplast. It is a passive and rapid mechanism. The flow of ions of elements is down a gradient of electrochemical potential energy.
  - **In the second phase**, ions are taken in the inner space of the cell, i.e. symplast at the expense of metabolic energy and hence is the **active process**. The movement of ions from cell to cell is called **flux**. It is **influx** (inward movement of ions into the cell) or **efflux** outward movement of ions from the cells).

Translocation of Solutes

- After absorption, the mineral salts pass readily with the ascending stream of water.
- The translocation of mineral elements to different parts of the body is done through **tracheary elements** of the xylem to reach upwardly to the leaves and other parts.
- It is done through the plants by the process of **transpirational pull**.

Soil as Reservoir of Essential Elements

- Soil itself acts as a mineral nutrient reservoir in natural conditions, but it is not essential for the growth of plant.
- The mineral elements become available to the roots of plants by the weathering and breakdown of rocks. Due to which the soil becomes enriched with ions and inorganic salts that are ultimately been taken up by the plants.
- Following functions are performed by the soil
  - It contains a wide variety of substances essential for plants.
  - Soil supplies minerals to plant and also harbours nitrogen-fixing bacteria and other microbes.
  - It also acts as a matrix that helps in the stabilisation of plants.
  - It holds water and supplies air to the roots.

Metabolism of Nitrogen

Nitrogen is one of the most prevalent elements in living organisms. It is the component of amino acid, proteins, hormones, chlorophyll and many vitamins. Thus, its uptake by plants becomes important.

Nitrogen Cycle

It is the cyclic process by which free atmospheric nitrogen is converted into its various chemical forms. The nitrogen cycle consists of four important processes

- **Nitrogen-fixation** In this process, atmospheric nitrogen is fixed into a form which can be used by the plants and animals. In this step,the molecular nitrogen (N_2) is converted into inorganic nitrogenous compounds like nitrate, nitrite and ammonia. Both physical factors like light, electric discharge, etc., and biological factors like bacteria and cyanobacteria are included in this process.
- **Ammonification** In this step, organic matter like proteins and nucleic acids of the dead remains are decomposed in order to produce ammonia (NH_3) by microorganisms (like *Actinomycetes, Clostridium*, etc). Out of this ammonia produced, some of the ammonia gets volatilised and re-enters into the atmosphere while most of it undergoes the process of nitrification by soil bacteria.
- **Nitrification** It is the process where ammonia is first oxidised to nitrite by the soil bacterium *Nitrosomonas* or *Nitrococcus*. This nitrite is then further oxidised to nitrate by another soil bacterium, i.e. *Nitrobacter*. The nitrate formed by these nitrifying bacteria is then absorbed by plants.
- **Denitrification** It is the process in which the nitrate present in the soil is reduced back to free nitrogen (N_2). The process of denitrification is carried out by denitrifying bacteria like *Thiobacillus denitrificans*, *Pseudomonas denitrificans*, etc.

Biological Nitrogen-Fixation

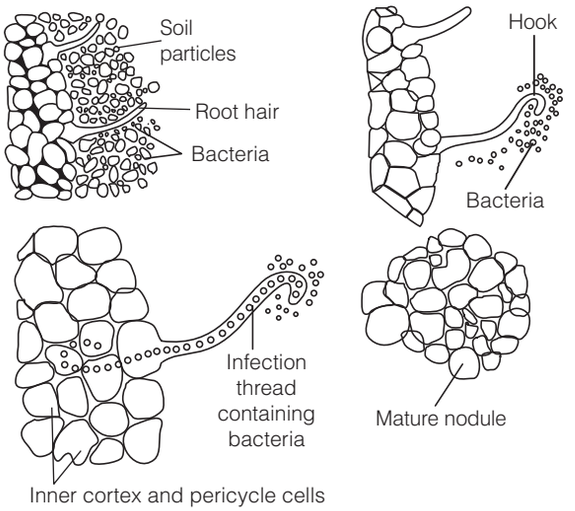
- Only a few living organisms can utilise the available atmospheric nitrogen readily. Thus, it has to be fixed into some absorbable form. This fixing can only be done by prokaryotic species.
- The process of reducing atmospheric nitrogen to ammonia by living organisms is called biological nitrogen-fixation. The nitrogen-fixing enzyme is nitrogenase.
- The nitrogen-fixing microbes could be free-living or symbiotic. Free-living nitrogen-fixers are included *Azotobacter* and *Beijerinckia* while symbiotic nitrogen-fixers are *Rhizobium* and *Frankia*.

1. Symbiotic Biological Nitrogen-Fixation

- The most prominent symbiotic biological nitrogen-fixing association is the legume-bacteria relationship. *Rhizobium* is the chief bacteria involved in symbiotic biological nitrogen-fixation and are associated with roots of leguminous plants and form root nodules.
- These nodules are small outgrowths on the roots. *Frankia* also produces nitrogen-fixing nodules on the roots of non-leguminous plants (e.g. *Alnus*).

2. Nodule Formation

- It involves a sequence of multiple interactions between *Rhizobium* and roots of the host plant which have been summarised as
  - *Rhizobium* multiplies and colonises the surroundings of roots and gets attached to epidermal and root hair cells.
  - Root hairs curl and the bacterium invades the root hair.
  - An infection thread is produced carrying the bacterium into the cortex of the root, where it initiates nodule formation in cortex of root.
  - Bacterium is released from the thread into cells, which leads to the differentiation of specialised nitrogen-fixing cells.
  - Nodule established a direct vascular connection with the host for exchange of nutrients.



Development of root nodules in soybean

- The nodule contains all the necessary biochemical components such as the enzyme nitrogenase (a Mo-Fe protein) and leghaemoglobin (Fe containing protein). The enzyme nitrogenase catalyses the conversion of atmospheric nitrogen into ammonia as given in the reaction below

$$N_2 + 8e^- + 8H^+ + 16\,ATP \longrightarrow 2NH_3 + H_2 + 16ADP + 16Pi$$

Importance of leghaemoglobin The enzyme nitrogenase is highly sensitive to molecular oxygen and thus requires anaerobic conditions.

To protect these enzymes, the nodule contains an oxygen scavenger pigment called **leghaemoglobin**. It is a pink coloured iron containing protein which traps molecular oxygen present in the nodule to create anaerobic conditions needed for nitrogenase activity.

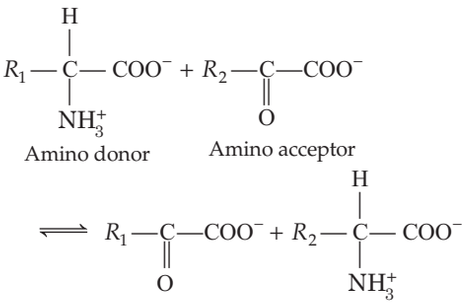
Fate of Ammonia

Two ways by which NH_4^+ is used to synthesise amino acids in plants are given below

- **Reductive amination** Ammonia reacts with α-ketoglutaric acid and forms glutamic acid as given in the reaction below

$$\alpha\text{-ketoglutaric acid} + NH_4^+ + NADPH \xrightarrow{\text{Glutamate dehydrogenase}} \text{Glutamate} + H_2O + NADP$$

- **Transamination** It involves the transfer of amino group from one amino acid to the keto group of a keto acid.
  - Glutamic acid is the main amino acid from which the transfer of NH_2, the amino group takes place and other amino acids are formed through transamination.
  - Enzyme **transaminase** catalyses all such reactions.



- The amino acids are further converted into amides. Asparagine and glutamine are the two most important amides, which are a structural part of proteins.
- These are formed from aspartic acid and glutamic acid. Amides contain more nitrogen than amino acids and are transported *via* xylem vessels in plant parts.

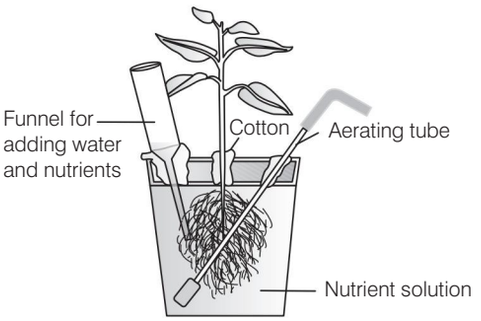
Mastering NCERT

MULTIPLE CHOICE QUESTIONS

TOPIC 1 ~ *Methods to Study the Mineral Requirements of Plants*

1 Growing plant in nutrient solution in complete absence of soil was first demonstrated by
(a) Charles Darwin, 1858 (b) Julius von Sachs, 1860
(c) Agnes Arber, 1938 (d) Hugo von Mohl, 1850

2 What does the given experimental setup depict?

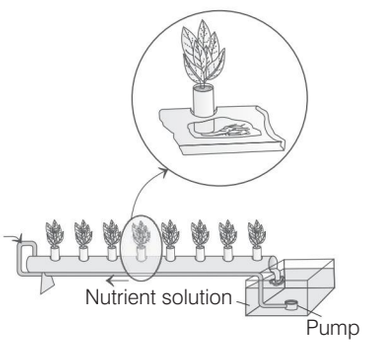


Choose the correct option.
(a) O_2 evolves during photosynthesis
(b) CO_2 is required during photosynthesis
(c) Measurement of the growth of a plant
(d) Plant grown in nutrient solution culture

3 The technique of growing plants in a nutrient solution in the complete absence of soil is called
(a) plant tissue culture (b) hydroponics
(c) plant breeding (d) Both (a) and (b)

4 Hydroponics has been successfully employed as a technique for which of the following vegetables?
(a) Seedless cucumber (b) Tomato
(c) Lettuce (d) All of these

5 Refer to the given experimental setup and choose the incorrect option.



(a) It shows hydroponic plant production
(b) Plants are grown in a tube or through place on a slight incline
(c) The solution flows down the tube and returns to the reservoir due to the suction pressure created by pump
(d) The roots in this setup are continuously bathed in aeration nutrient solution

6 In order to obtain the optimum growth through hydroponics, nutrient solution must be
(a) poorly aerated
(b) adequately aerated
(c) diluted
(d) None of the above

7 By applying which of the following practices, contamination of hydroponic culture medium can be reduced?
(a) Change the medium every week
(b) Do not use tools from the outdoor garden
(c) Complete aeration in hydroponic tank
(d) All of the above

8 In hydroponics, the nutrient solution
(a) is constantly recycled using a pump
(b) flows back into the loam soil in which the plant grows
(c) is collected into a bucket for disposal
(d) None of the above

9 Soilless culture helps in knowing
(a) toxicity caused by an element
(b) deficiency symptoms caused by an element
(c) essentiality of an element
(d) All of the above

10 Major disadvantages of hydroponics include
(a) expense to setup
(b) high technical knowledge
(c) conserve water
(d) Both (a) and (b)

11 Which of the following methods is close to hydroponics and has the same principle?
(a) Aeroponics
(b) Geoponics
(c) Planting
(d) None of the above

TOPIC 2 ~ *Essential Mineral Elements*

12 Most of the minerals present in soil can enter plants through …… .
(a) leaves (b) root hair (c) shoots (d) phloem

13 More than……elements, of the 105 discovered, so far are found in different plants.
Fill in the blank to complete the given statement.
(a) 65 (b) 60 (c) 62 (d) 56

14 The minerals can be detected even at the concentration as low as
(a) 10^{-5} g/mL (b) 10^{-7} g/mL
(c) 10^{-8} g/mL (d) None of these

15 What effect can be seen on the plant growth and reproduction in the absence of essential mineral element?
(a) Plants will complete their life cycle normally
(b) Plants will not complete their life cycle
(c) There will be no effect on the normal growth, but reproduction in plants will suffer
(d) Only growth will get affected not the reproduction

16 An essential element is that, which
(a) improves health of the plant
(b) is irreplaceable and indispensable for growth of plants
(c) is found in plant ash
(d) is available in the soil

17 Maximum amount of macronutrients that is generally present in plant tissue is
(a) 10.5 m mole kg^{-1} of dry matter
(b) 9.5 m mole kg^{-1} of dry matter
(c) 1.0 m mole kg^{-1} of dry matter
(d) 10 m mole kg^{-1} of dry matter

18 In which of the following all three options are macronutrients? ***NEET 2016***
(a) Iron, copper, molybdenum
(b) Molybdenum, magnesium, manganese
(c) Nitrogen, sulphur, phosphorus
(d) Boron, zinc, manganese

19 Which of the following is not a micronutrient? ***JIPMER 2019***
(a) Molybdenum (b) Magnesium
(c) Zinc (d) Boron

20 Minerals known to be required in large amounts for plant growth include ***CBSE-AIPMT 2015***
(a) phosphorus, potassium, sulphur, calcium
(b) calcium, magnesium, manganese, copper
(c) potassium, phosphorus, selenium, boron
(d) magnesium, sulphur, iron, zinc

21 Which of the following is not considered as a trace element (micronutrient) in the plant?
(a) Mo (b) Cu (c) Mn (d) K

22 Which of the following pairs of elements are considered as beneficial elements in higher plants?
(a) Sodium and iron
(b) Silicon and potassium
(c) Cobalt and selenium
(d) All of the above

23 In addition to the 17 essential elements, there are some beneficial elements also. These are required by the
(a) small plants (b) very small plants
(c) higher plants (d) All of these

24 Identify the element, which functions as a components of the biomolecules?
(a) Hydrogen (b) Oxygen
(c) Nitrogen (d) All of these

25 Macronutrients like carbon, hydrogen and oxygen are obtained mainly from
(a) CO_2 (b) H_2O
(c) Soil (d) Both (a) and (b)

26 Which of the following is a component of ATP ?
(a) Potassium (b) Magnesium
(c) Phosphorus (d) Manganese

27 Name the essential element that is considered as the component of energy-related chemical compound in plant's chlorophyll.
(a) Magnesium (b) Phosphorus
(c) Manganese (d) Potassium

28 Choose the correct option for the match given below about the element which acts as activator of certain enzymes.

Activator element		Enzyme
(a) Mg^{2+}	–	RuBisCO, PEPCase
(b) Zn^{2+}	–	Alcohol dehydrogenase
(c) Mo	–	Nitrate reductase

(d) All of the above

29 Mineral element, required by plants in the greatest amount is
(a) nitrogen (b) potassium
(c) phosphorus (d) zinc

30 Nitrogen is absorbed by the plants in the form of
(a) NO_3^- (b) NH_4^+
(c) NO^- (d) Both (a) and (b)

31 Nitrogen is required mainly by which of the following parts of the plants?
(a) Meristematic tissues (b) Metabolically active cells
(c) Permanent tissues (d) Both (a) and (b)

32 Which among the following is the major constituent of proteins, nucleic acids, vitamins and hormones?
(a) K (b) N (c) P (d) S

33 Phosphorus is absorbed by the plants as
(a) $H_2PO_4^-$ (b) HPO_4
(c) HPO_4^{2-} (d) Both (a) and (c)

34 Phosphorus is not a structural element in
(a) nucleic acids (b) proteins
(c) nucleotide (d) carbohydrate

35 Potassium is required by which of the following regions of plants?
(a) Meristematic tissues (b) Buds
(c) Leaves (d) All of these

36 Which one of the following elements is responsible for maintaining turgor pressure in cells? ***NEET 2018***
(a) Potassium (b) Sodium
(c) Magnesium (d) Calcium

37 The mineral element which helps in protein synthesis, opening and closing of stomata and activation of enzymes is
(a) Ca^{2+} (b) K^+ (c) Mg^{2+} (d) Fe^{3+}

38 Ca^{2+} is an essential element of plants. Its major function is
(a) to provide selective permeability of the cell membrane
(b) maintenance of the cell turgidity
(c) organisation of mitotic spindle
(d) Both (a) and (c)

39 Which is essential for the growth of root tip? ***NEET 2016***
(a) Zn (b) Fe (c) Ca (d) Mn

40 Element present in middle lamella is
(a) Zn (b) Cu (c) Ca (d) K

41 Sulphur is found as a constituent in which of the following amino acids?
(a) Cysteine (b) Methionine
(c) Alanine (d) Both (a) and (b)

42 Choose the correct option.
(a) Calcium accumulates in older leaves
(b) Magnesium helps maintain the ribosome structure
(c) Sulphur is the constituent of ferredoxin
(d) All of the above

43 In which of the following forms, iron is absorbed by plants? ***NEET 2018***
(a) Free element (b) Ferrous
(c) Ferric (d) Both ferric and ferrous

44 Enzymes involved in respiration are activated by which of the following pairs of elements?
(a) Sulphur and iron
(b) Potassium and calcium
(c) Nitrogen and phosphorus
(d) Magnesium and manganese

45 The essential element for the synthesis of auxin
(a) zinc (b) sulphur
(c) potassium (d) phosphorus

46 Minerals involved in redox reactions in plant cells are
(a) N, Cu (b) Fe, Cu (c) Ca, Fe (d) Na, Cu

47 The minerals responsible for maintaining cation-anion balance in the plant cells are
(a) K^+ and Fe^{3+} (b) Cl^- and K^+
(c) Ca^{2+} and Mg^{2+} (d) Cl^- and Mg^{2+}

48 The deficiencies of micronutrients not only affect the growth of the plants, but also its vital functions, such as photosynthesis and mitochondrial electron flow. Among the list given below, which group of three elements will mostly affect, both photosynthesis and mitochondrial electron transport?
(a) Cu, Mn and Fe (b) Co, Ni and Mo
(c) Mn, Co and Ca (d) Ca, K and Na

49 A small aquatic plant was put in three petri dishes labelled as *X*, *Y* and *Z*, containing different culture solutions. After six weeks, the plants in dish *X* had the same number of leaves as it had previously and they all were small and yellowish. Plant in dish *Y* had leaves with purple-reddish spots on them. Plants in dish *Z* had leaves bearing scorched tips. Identify the missing elements in all the three petridishes (*X*, *Y*, *Z*).
(a) X–Magnesium, Y–Phosphorus, Z–Potassium
(b) X–Phosphorus, Y–Magnesium, Z–Nitrogen
(c) X–Phosphorus, Y–Nitrogen, Z–Magnesium
(d) X–Magnesium, Y–Nitrogen, Z–Phosphorus

50 Farmers in a particular region were concerned that premature yellowing of leaves of a pulse crop might cause decrease in the yield of crop. Which treatment could be most beneficial to obtain the maximum seed yield?
(a) Frequent irrigation of the crop
(b) Removal of all yellow leaves and spraying the remaining green leaves with 2, 4, 5-trichlorophenoxy acetic acid
(c) Treatment of the plants with cytokinins along with a small dose of nitrogenous fertiliser
(d) Application of iron and magnesium to promote the synthesis of chlorophyll

51 Choose the correct option for the element required during water-splitting reaction in photosynthesis.
(a) Fe, Cu (b) Mn, Cl
(c) Zn, Cu (d) Bo, Mo

52 Mineral, which is not essential for plants.
(a) Na (b) K (c) Zn (d) Fe

53 Micronutrient, which is important in transport of sugar, utilisation of Ca^{2+} and cell division is
(a) phosphorus (b) boron
(c) potassium (d) sulphur

54 Which of the following is not caused by the deficiency of minerals?
(a) Chlorosis
(b) Etiolation
(c) Shortening of internodes
(d) Necrosis

55 Premature leaf fall is a disease caused due to the deficiency of
(a) phosphorus (b) iron
(c) calcium (d) potassium

56 Necrosis is the term used for the
(a) falling of leaves
(b) delay in flowering
(c) death of plant tissues
(d) inhibition of cell division in plants

57 Deficiency symptoms of nitrogen, magnesium and potassium are visible first in ***CBSE-AIPMT 2014***
(a) senescent leaves
(b) young leaves
(c) roots
(d) buds

58 Which of the following elements cause necrosis due to their deficiency?
(a) N, K and S (b) N, K, Mg and Fe
(c) Mn, Zn and Mo (d) Ca, Mg, Cu and K

59 Mineral ion concentration in tissues that reduce the dry weight of tissues by about 10% is considered as
(a) critical concentration (b) toxic concentration
(c) optimum concentration (d) beneficial concentration

60 Which of the following is true regarding manganese toxicity in plants?
(a) Induction of deficiency of iron, magnesium and calcium
(b) Appearance of brown spots surrounded by chlorotic veins
(c) Inhibition of Ca^{2+} translocation in the shoot apex
(d) All of the above

TOPIC 3 ~ *Mechanism of Absorption of Elements*

61 In the initial phase of mineral absorption, ions are taken up rapidly into the …… space of cells.
(a) outer (b) inner
(c) semiouter (d) None of these

62 In the initial phase of mineral absorption, ions are taken up
(a) slowly
(b) rapidly
(c) rate of absorption depends upon the mineral ion
(d) None of the above

63 During the uptake of ions in the first phase, absorption of minerals occurs through
(a) active movement of ions
(b) passive movement of ions
(c) Both (a) and (b)
(d) None of the above

64 In the final phase of mineral absorption, ions are taken up into the……space of cells.
(a) outer
(b) inner
(c) extra inner membrane
(d) None of the above

65 Active transport of ions by the cell requires
(a) alkaline pH (b) salts
(c) high temperature (d) ATP

66 In the final phase of mineral absorption, ions are taken up
(a) slowly
(b) rate of absorption depends upon the mineral ion
(c) very fast
(d) None of the above

67 During the uptake of ions in the second phase, absorption of minerals occurs
(a) by passive movement of ions
(b) with expenditure of energy
(c) without expenditure of energy
(d) None of the above

68 Efflux is the movement of ions
(a) out of the cell (b) within the cell
(c) into the cell (d) None of these

69 Mineral salts are translocated through …… , which is pulled up through the plants by transpirational pull. The use of …… helps to confirm this.
(a) phloem, staining technique
(b) xylem, radioisotopes
(c) shoot apex, staining technique
(d) root tip, radioisotopes

70 Why is soil considered essential for plants?
(a) Inorganic nutrients are derived from rock minerals
(b) Soil harbours nitrogen-fixing bacteria
(c) Soil acts as matrix that stabilises plants
(d) All of the above

TOPIC 4 ~ *Metabolism of Nitrogen*

71 Which of the following is a limiting nutrient for both natural and agricultural ecosystems?
(a) Carbon (b) Nitrogen (c) Sulphur (d) Hydrogen

72 Two nitrogen atoms are joined by
(a) a double covalent bond
(b) ionic bond
(c) a triple covalent bond
(d) None of the above

73 The first stable product of fixation of atmospheric nitrogen in leguminous plants is ***NEET 2013***
(a) NO_2^- (b) ammonia (c) NO_3^- (d) glutamate

74 Decomposition of organic nitrogen of dead plants and animals into ammonia is called
(a) nitrification (b) denitrification
(c) ammonification (d) nitrogen-fixation

75 Which of the following is a characteristic feature of nitrifying bacteria?
(a) Oxidise ammonia to nitrates
(b) Convert proteins into ammonia
(c) Convert free nitrogen to nitrogen compounds
(d) Reduce nitrates to free nitrogen

76 The soil area around the plant roots associated with the soil microorganisms is called
(a) phyllosphere (b) rhizosphere
(c) Both (a) and (b) (d) None of these

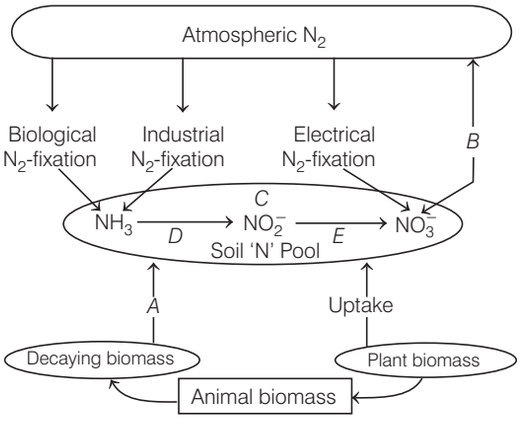
77 Observe the steps given below for nitrification

$$2NH_3 + 3O_2 \longrightarrow 2NO_2^- + 2H^+ + 2H_2O$$

$$2NO_2^- + O_2 \longrightarrow 2NO_3^-$$

The steps given above are carried out by
(a) *Nitrobacter* (b) *Nitrosomonas*
(c) *Nitrococcus* (d) All of these

78 Identify *A* to *D* in the given flow diagram which links the major nitrogen pools and choose the correct combination from the options given below.

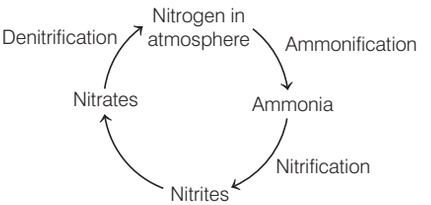


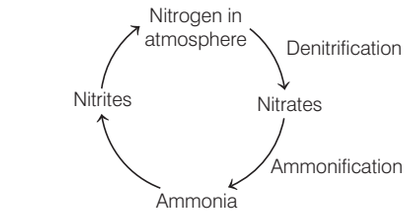
(a) A–Nitrification, B–Ammonification, C–*Nitrobacter*, D–*Nitrosomonas*
(b) A–Ammonification, B–Denitrification, C–Nitrification, D–*Nitrosomonas*, E–*Nitrobacter*
(c) A–Denitrification, B–*Nitrobacter*, C–Nitrification, D–*Nitrosomonas*, E–Ammonification
(d) A–*Nitrobacter*, B–Denitrification, C–*Nitrosomonas*, D–Ammonification

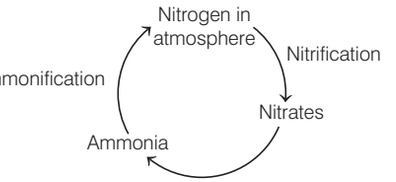
79 Which of the following is a bacterium involved in denitrification?
(a) *Azotobacter* (b) *Nitrosomonas*
(c) *Pseudomonas* (d) *Nitrobacter*

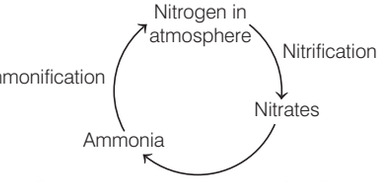
80 Which of the following bacteria reduces nitrate in soil into nitrogen? ***NEET (Odisha) 2019***
(a) *Nitrobacter* (b) *Nitrococcus*
(c) *Thiobacillus* (d) *Nitrosomonas*

81 Which of the following diagrams correctly depicts N_2-cycle?

(a)


(b)


(c)


(d)


82 Reduction of nitrogen to ammonia by living organisms is called
(a) biological nitrogen-fixation
(b) nitrification
(c) denitrification
(d) assimilation

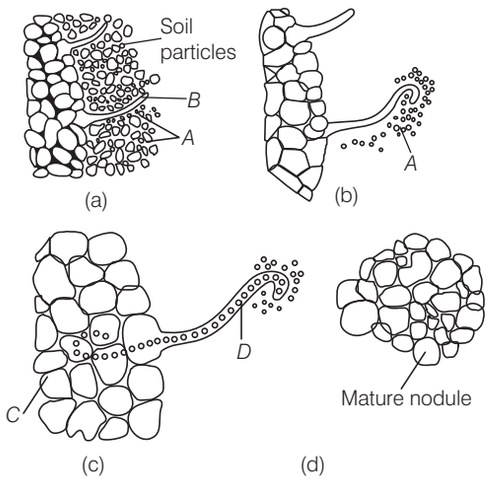
83 Free-living nitrogen-fixing bacteria is
(a) *Bacillus polymixa* (b) *Pseudomonas*
(c) *E. coli* (d) *Anabaena*

84 Which one of the following organisms are added as nitrogen-fixers in the rice field cultivation?
(a) *Alnus* (b) *Azolla* (c) *Cycas* (d) *Marchantia*

85 Identify the non-leguminous plant that forms nodules to fix nitrogen.
(a) *Alnus* (b) *Pinus* (c) *Cycas* (d) None of these

86 I. Leghaemoglobin is a unique ...*A*... and is chemically similar to the ...*B*... found in animal system.
II. ...*C*... is a very important constituent of ferredoxin, which plays an important role in biological N_2-fixation.
III. In root nodules of leguminous plant, a red pigment, called ...*D*... is present, which is located in the membrane.
Fill in the blanks (*A*-*D*).
(a) A–protein, B–haemoglobin, C–leghaemoglobin, D–iron
(b) A–iron, B–leghaemoglobin, C–protein, D–haemoglobin
(c) A–protein B–leghaemoglobin, C–iron, D–haemoglobin
(d) A–protein, B–haemoglobin, C–iron, D–leghaemoglobin

87 Identify the *A* to *D* correctly in the given diagram of root nodule development and choose the correct option accordingly.



(a) A–*Rhizobium* bacteria, B–Cortex cell, C–Outer cortex, D–Infection thread
(b) A–*Rhizobium* bacteria, B–Root hair, C–Inner cortex, D–Infection thread
(c) A–*Rhizobium* bacteria, B–Endodermal cell, C–Inner endodermis, D–Infection thread
(d) A–*Nitrosomonas* bacteria, B–Root hair, C–Inner cortex, D–Infection thread

88 Enzyme involved in nitrogen metabolism is
(a) phosphoenol pyruvate carboxylase
(b) ribulose bisphosphate carboxylase oxygenase
(c) nitrogenase
(d) alcohol dehydrogenase

89 The function of leghaemoglobin in the root nodules of legumes is
(a) oxygen removal
(b) inhibition of nitrogenase activity
(c) expression of *nif* gene
(d) nodule differentiation

90 During N_2-fixation, reduction of one molecule of N_2 into two molecules of NH_3 consumes……molecules of ATP.
(a) 4 (b) 16
(c) 56 (d) 38

91 Various factors affect biological nitrogen-fixation by microbes. Identify the one which greatly and adversely affect the nitrogen-fixation.
(a) light (b) soil pH
(c) temperature (d) air

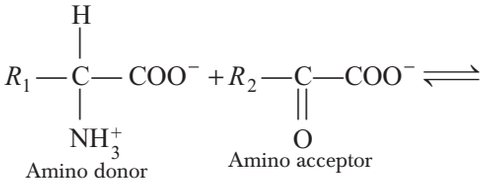
92 Which one is the correct summarised equation for nitrogen-fixation?
(a) $N_2 + 8e^- + 8H^+ + 8ATP \longrightarrow NH_3 + H_2 + 16ADP + 16Pi$
(b) $N_2 + 8e^- + 8H^+ + 16ATP \rightarrow 2NH_3 + H_2 + 16ADP + 16Pi$
(c) $2NH_3 + 4O_2 \longrightarrow 2H^+ + 2H_2O + 2NO_3^-$
(d) $2\,NH_3 + 3O_2 \rightarrow 2\,NO_2^- + 2\,H^+ + 2\,H_2O$

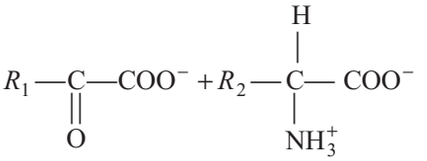
93 The following reaction represents

$$\alpha\text{-ketoglutaric acid} + NH_4^+ + NADPH \xrightarrow[\text{dehydrogenase}]{\text{Glutamate}} \text{Glutamate} + H_2O + NADP$$

(a) reductive amination (b) transamination
(c) amination (d) nitrification

94 What does the given reaction show?





Choose the correct option.
(a) Oxidative deamination
(b) Reductive amination
(c) Transamination
(d) Deamination

95 The two most abundant amides found in plants are
(a) asparagine and glutamine
(b) lysine and asparagine
(c) glutamine and lysine
(d) None of the above

NEET

SPECIAL TYPES QUESTIONS

I. Assertion and Reason

Direction (Q. No. 96-104) *In each of the following questions, a statement of Assertion (A) is given by corresponding statement of Reason (R). Of the statements, mark the correct answer as*

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true, but R is not the correct explanation of A
(c) If A is true, but R is false
(d) If A is false, but R is true

96 **Assertion** (A) Every plant can grow in a suitable mineral solution only (i.e. without soil).

Reason (R) Hydroponics does not help in the identification of essential elements and deficiency symptoms of the plants.

97 **Assertion** (A) Hydroponics requires continuous supply of purified water and mineral nutrient salts.

Reason (R) Purified water and mineral salts are always not essential for the growth of plants in hydroponics.

98 **Assertion** (A) Warm nutrient solution is better than cold solution for hydroponics.

Reason (R) Cold solution can hold greater amount of oxygen than warm solution.

99 **Assertion** (A) Some essential elements can alter the osmotic potential of a cell.

Reason (R) Osmotic potential in plants can be regulated by potassium ions.

100 **Assertion** (A) Nitrate reduction requires manganese.

Reason (R) Activator of the enzyme reductase involved in nitrate reduction is manganese.

101 **Assertion** (A) Magnesium is important in photosynthesis and carbohydrate metabolism.

Reason (R) Mg^{2+} is involved in the synthesis of nucleic acids. ***AIIMS 2018***

102 **Assertion** (A) Active absorption of minerals is inhibited when the roots are deprived of oxygen.

Reason (R) Active absorption of minerals requires expenditure of metabolic energy, which comes from aerobic respiration.

103 **Assertion** (A) Leguminous plants are symbiotic nitrogen-fixers.

Reason (R) Leguminous plants have the rod-shaped *Rhizobium* symbiotically associated with their roots.

104 **Assertion** (A) Nitrogen-fixing bacteria of legume root nodules survive in oxygen depleted cells.

Reason (R) Leghaemoglobin completely removes oxygen from nodule cells. ***AIIMS 2018***

II. Statement Based Questions

105 Choose the correct statement regarding essential mineral elements of plants among the following.

(a) Minerals present in the soil cannot enter into the plants
(b) Gold is the only element, which cannot be accumulated by the plants
(c) Plants growing near the nuclear test sites take up the radioactive strontium
(d) Minerals present in very low concentration cannot be detected and hence they remain undiscovered

106 Choose the incorrect statement among the following.

(a) More than 60 elements, out of 105 discovered are found in plants
(b) Plants take carbon, hydrogen and oxygen mainly from CO_2 and H_2O present in air and soil
(c) The element, which is not directly involved in the metabolism of plant is referred to as an essential element
(d) The elements like gold, selenium and strontium although can be absorbed by the plant, but have no role in them

107 Choose the incorrect statement from the following.

(a) Nitrogenase enzyme is protected from O_2 in the nodules of legume plants
(b) Nitrogenase enzyme is highly insensitive to the presence of moleuclar oxygen
(c) leghaemoglobin is oxygen scavenger and creates anaerobic conditions in the roots of leguminous plants
(d) *Rhizobium* is an aerobic bacterium in free-living conditions

108 Choose the correct option.

(a) Amides are the transported forms of nitrogen as they have more nitrogen
(b) Legumes of tropical origin (e.g. soybean) transport ureides
(c) The host produces globin part and bacterial symbiont produces haem part of leghaemoglobin (N_2-fixing pigment)
(d) All of the above

109 Which of the following statements is/are incorrect with respect to hydroponics?

I. Hydroponics involves the culture of plants in a soil-free mineral nutrient solution.

II. Hydroponics requires purified water with non-defined mineral nutrient salts.

III. In hydroponics technique, plants are grown in sandy soil with nutrient solution.

IV. By this method, essential elements required for the growth of plants can be identified and their deficiency symptoms can also be discovered.

(a) I, II and IV (b) II and IV
(c) Only II (d) None of these

110 Consider the following statements about hydroponics and choose the correct pair of statements from the given options.

I. Hydroponics technique is useful in areas having infertile and dry soils.

II. Hydroponics can regulate pH, optimum for a particular crop.

III. It reduces the labour cost of growing crops.

IV. It increases the problem of weeding.

(a) I and IV (b) I and II
(c) I and III (d) Only I

111 Read the following statements about essential elements and choose the correct option.

I. The element is necessary for supporting normal growth and reproduction of the plants.

II. The deficiency of that particular element cannot be met by supplying some other elements.

III. The element is directly involved in the metabolism of the plants.

(a) I and III (b) Only II (c) II and III (d) I, II and III

112 Read the following statements about the functions of essential elements.

I. Maintenance of permeability of the cell membrane.

II. Maintenance of osmotic concentration of the cell sap.

III. Major constituents of macromolecules and coenzymes.

IV. Buffering action.

Choose the correct option.

(a) Only III (b) I and III
(c) Only I (d) I, II, III and IV

113 Read the following statements about the essential element, identify and choose the correct option.

I. Activator of catalase.

II. Important constituent of cytochrome.

III. Important constituent of proteins involved in ETS.

IV. Essential for chlorophyll synthesis.

(a) Mo (b) Fe
(c) Cu (d) Ca

114 Mark the statements as true/false by choosing the correct option from the codes given below.

I. Magnesium is a constituent of chlorophyll and helps to maintain the ribosome structure.

II. Calcium is needed during the formation of mitotic spindle.

III. Magnesium is essential for the photolysis of water.

IV. Zinc helps in sugar translocation.

Codes

	I	II	III	IV
(a)	True	True	False	False
(b)	True	True	False	True
(c)	True	False	True	False
(d)	False	False	True	True

115 Consider the following statements.

I. Soil provide plant with essential organic and inorganic salts.

II. Majority of nutrients that are essential for growth and development of plants become available to roots due to weathering and breakdown of rocks.

(a) Statement I is true, but II is false
(b) Statement II is true, but I is false
(c) Both statements I and II are true
(d) Both statements I and II are false

116 Which of the following statements are correct about mineral absorption in plants?

(a) In the initial phase, ions are taken up into the outer space of cells, the apoplast, it is a passive process

(b) In the final phase, ions are taken slowly into the inner space, the symplast of cells and it is an active process

(c) Passive movement of the ions into the apoplast occurs through ion channels, transmembrane proteins, which act as selective pores

(d) All of the above

117 Nodule formation involves a sequence of multiple interactions between *Rhizobium* and roots of the host plant. The principal stages in the nodule formation are given below.

I. A mature nodule establishes a direct vascular connection with the host for exchange of nutrients.

II. Root hair curls and the bacteria invade the root hair.

III. *Rhizobia* multiply and colonise the surrounding of roots and get attached to epidermal and root hair cells.

IV. The infection thread is produced carring the bacteria and grows into the cortex of the root.

V. The bacteria get modified into rod-shaped bacteroids and cause inner cortical layer and pericycle to divide to form nodule.

The correct sequence is

(a) III → II → IV → I → V
(b) III → II → IV → V → I
(c) IV → V → III → II → I
(d) I → III → V → II → IV

118 Choose the incorrect statement.

I. Plant obtains Mo in the form of MoO_2^{2+} and it is the component of several enzymes including nitrogenase and nitrate reductase.

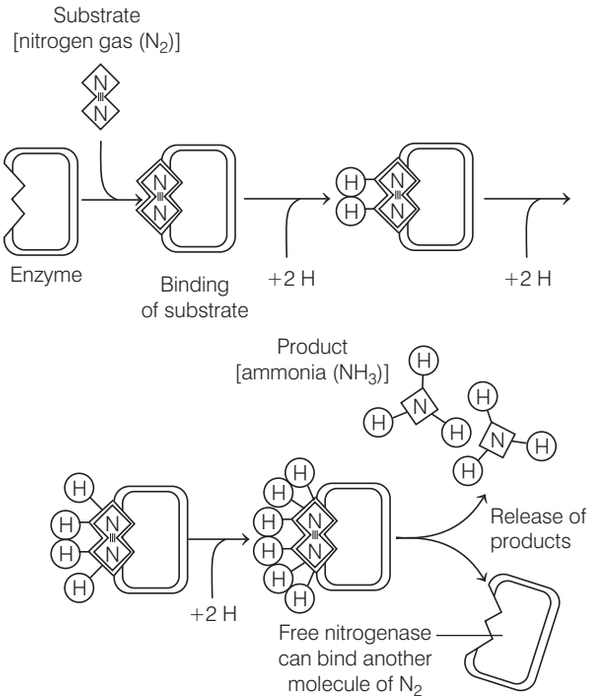
II. The concentration of the essential elements above which plant growth is retarded is termed as critical concentration.

III. Deficiency symptoms are structural changes in the plant due to certain element deficiency.

IV. Deficiency symptoms disappear if the specific nutrient is provided to the plant, also if the deprivation continues death of plant occurs.

(a) I and II (b) III and IV
(c) II and III (d) I and IV

119 Pick the correct set of statements for the given diagram of N_2-fixation and choose the correct option.



I. Nitrogenase catalyses the reaction.

II. The formation of ammonia is a reductive process.

III. One molecule of nitrogen produces two molecules of ammonia.

IV. Formation of ammonia is an oxidative reductive process.

Select the option depicting the correct statement.

(a) I, II and III
(b) I, II and IV
(c) II, III and IV
(d) I, III and IV

120 Study the following statements regarding leghaemoglobin and choose the option for incorrect statement(s).

I. The central portion of root nodule found in leguminous plant is white.

II. Root nodule of leguminous plant contains both enzyme nitrogenase and leghaemoglobin.

III. Leghaemoglobin traps molecular O_2 to create anaerobic conditions need for activity of nitrogenase enzyme.

(a) I is correct, II and III are incorrect
(b) I is incorrect, II and III are correct
(c) Only II is incorrect
(d) I and II are incorrect

III. Matching Type Questions

121 Match the following columns.

	Column I (Elements)		Column II (Types/Functions)
A.	Manganese	1.	Macronutrient
B.	Magnesium	2.	Component of biomolecules
C.	Phosphorus	3.	Micronutrient
D.	Nitrogen	4.	In the formation of ATP

Codes

	A	B	C	D
(a)	4	3	1	2
(b)	4	2	3	1
(c)	1	3	4	2
(d)	3	1	4	2

122 Match the following columns.

	Column I (Location)		Column II (Elements)
A.	Found in some vitamins (thiamine, biotin, coenzyme-A)	1.	Mg
B.	Required for photolysis of water	2.	I
C.	Not important for plants	3.	S
D.	Present at the centre of porphyrin ring in chlorophyll	4.	Mn

Codes

	A	B	C	D
(a)	4	1	2	3
(b)	3	4	1	2
(c)	1	2	4	3
(d)	3	4	2	1

123 Match the following columns.

	Column I (Functions)		Column II (Elements)
A.	Water splitting reaction	1.	Boron
B.	Uptake and utilisation of Ca^{2+}	2.	Copper
C.	Synthesis of auxin	3.	Cl^-
D.	Redox reaction	4.	Zinc

Codes

	A	B	C	D
(a)	1	3	2	4
(b)	3	1	4	2
(c)	2	3	1	4
(d)	4	2	1	3

124 Match the following columns.

	Column I (Mechanism)		Column II (Absorption mechanism)
A.	Movement of ions into or out of the cell	1.	Diffusion
B.	Outward movement is	2.	Flux
C.	Inward movement is	3.	Efflux
D.	Passive uptake	4.	Influx

Codes

	A	B	C	D
(a)	1	4	3	2
(b)	4	2	1	3
(c)	2	3	4	1
(d)	3	4	1	2

125 Match the following columns.

	Column I (Nitrogen fixers)		Column II (Plants)
A.	*Rhizobium leguminosarum*	1.	Cereal roots
B.	*Rhizobium japonicum*	2.	*Azolla* (fern)
C.	*Azospirillum brasiliense*	3.	Pea
D.	*Frankia* sp.	4.	Alfa-alfa
E.	*Anabaena* sp.	5.	Soybean
		6.	*Alnus*

Codes

	A	B	C	D	E
(a)	2	4	6	3	5
(b)	6	2	5	4	1
(c)	3	5	1	6	2
(d)	5	3	6	1	2

126 Match the organisms given in Column I to their functions given in Column II and choose the correct option.

	Column I		Column II
A.	*Thiobacillus*	1.	Free-living nitrogen- fixing cyanobacteria
B.	*Nitrosomonas*	2.	Denitrification
C.	*Nostoc*	3.	Free-living aerobic nitrogen-fixing bacteria
D.	*Azotobacter*	4.	NH_3 to nitrite

Codes

	A	B	C	D
(a)	2	4	1	3
(b)	4	1	3	2
(c)	3	4	1	2
(d)	3	2	4	1

127 Match the following columns.

	Column I (Nitrogen fixers)		Column II (Microbes)
A.	Cyanobacteria	1.	*Anabaena, Nostoc*
B.	Aerobic microbes	2.	*Azotobacter, Beijerinckia*
C.	Anaerobic microbes	3.	*Rhodospirillium*
D.	Symbiotic microbes	4.	*Rhizobium, Frankia*

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	4	3	2	1
(c)	3	1	4	2
(d)	2	4	1	3

NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

128 Purification of water and nutrient salts is done in studies involving mineral nutrition using hydroponics to
(a) remove impurities from the culture medium
(b) replenish depleted oxygen
(c) speed up the process
(d) Both (a) and (c)

129 In certain plants, deficiency symptoms appear first in younger part of plants, while in others they do so in mature organs
(a) because all nutrients are mobile
(b) because all nutrients are immobile
(c) because few nutrients are mobile, while some are immobile
(d) None of the above

NCERT Exemplar

130 Which one of the following roles is not characteristic of an essential element?
(a) Being a component of biomolecules
(b) Changing the chemistry of soil
(c) Being a structural component of energy related chemical
(d) Activation or inhibition of enzymes

131 Which one of the following statements can best explain the term critical concentration of an essential element?
(a) Essential element concentration below which plant growth is retarded
(b) Essential element concentration below which plant growth becomes enhanced
(c) Essential element concentration below which plant remains in the vegetative phase
(d) None of the above

132 Deficiency symptoms of an element tend to appear first in young leaves. It indicates that the element is relatively immobile. Which one of the following elemental deficiency would show such symptoms?
(a) Sulphur (b) Magnesium
(c) Nitrogen (d) Potassium

133 With regard to the biological nitrogen-fixation by *Rhizobium* in association with soybean, which one of the following statements does not hold true?
(a) Nitrogenase may require oxygen for its functioning
(b) Nitrogenase is Mo-Fe protein
(c) Leghaemoglobin is a pink coloured pigment
(d) Nitrogenase helps to convert N_2 gas into two molecules of ammonia

134 Reaction carried out by N_2-fixing microbes includes

I. $2NH_3 + 3O_2 \longrightarrow 2NO_2^- + 2H^+ + 2H_2O$

II. $2NO_2 + O_2 \longrightarrow 2NO_3$

Which of the following statements about these equations is not true?
(a) Step I is carried out by *Nitrosomonas* or *Nitrococcus*
(b) Step II is carried out by *Nitrobacter*
(c) Both steps I and II can be called nitrification
(d) Bacteria carrying out these steps are usually photoautotrophs

135 Which one of the following symptoms is not due to manganese toxicity in plants?
(a) Calcium translocation in shoot apex is inhibited
(b) Deficiency in both iron and nitrogen induced
(c) Appearance of brown spot surrounded by chlorotic veins
(d) None of the above

136 Match the element with its associated functions/roles and choose the correct option among given below.

	Nutrients		Process
A.	Boron	1.	Splitting of H_2O to liberate O_2 during photosynthesis
B.	Manganese	2.	Needed for synthesis of auxins
C.	Molybdenum	3.	Component of nitrogenase
D.	Zinc	4.	Pollen germination
E.	Iron	5.	Component of ferredoxin

Codes

	A	B	C	D	E
(a)	1	2	3	4	5
(b)	4	1	3	2	5
(c)	3	2	4	5	1
(d)	2	3	5	1	4

137 Plants can be grown in (tick the incorrect option).
(a) soil with essential nutrients
(b) water with essential nutrients
(c) either water or soil with essential nutrients
(d) water or soil without essential nutrients

Answers

Mastering NCERT with MCQs

1 (b)	2 (d)	3 (b)	4 (d)	5 (c)	6 (b)	7 (d)	8 (a)	9 (d)	10 (d)
11 (a)	12 (b)	13 (b)	14 (c)	15 (b)	16 (b)	17 (d)	18 (c)	19 (b)	20 (a)
21 (d)	22 (c)	23 (c)	24 (d)	25 (d)	26 (c)	27 (a)	28 (d)	29 (a)	30 (d)
31 (d)	32 (b)	33 (d)	34 (d)	35 (d)	36 (a)	37 (b)	38 (d)	39 (c)	40 (c)
41 (d)	42 (d)	43 (d)	44 (d)	45 (a)	46 (b)	47 (b)	48 (a)	49 (a)	50 (d)
51 (b)	52 (a)	53 (b)	54 (b)	55 (a)	56 (c)	57 (a)	58 (d)	59 (b)	60 (d)
61 (a)	62 (b)	63 (b)	64 (b)	65 (d)	66 (a)	67 (b)	68 (a)	69 (b)	70 (d)
71 (b)	72 (c)	73 (b)	74 (c)	75 (a)	76 (b)	77 (d)	78 (b)	79 (c)	80 (c)
81 (a)	82 (a)	83 (a)	84 (b)	85 (a)	86 (d)	87 (b)	88 (c)	89 (a)	90 (b)
91 (b)	92 (b)	93 (a)	94 (c)	95 (a)					

NEET Special Types Questions

96 (c)	97 (c)	98 (d)	99 (a)	100 (a)	101 (b)	102 (a)	103 (a)	104 (b)	105 (c)
106 (c)	107 (b)	108 (d)	109 (c)	110 (b)	111 (d)	112 (d)	113 (b)	114 (b)	115 (c)
116 (d)	117 (b)	118 (c)	119 (a)	120 (b)	121 (d)	122 (d)	123 (b)	124 (c)	125 (c)
126 (a)	127 (a)								

NCERT & NCERT Exemplar Questions

128 (d)	129 (c)	130 (b)	131 (a)	132 (a)	133 (a)	134 (d)	135 (b)	136 (b)	137 (d)

Answers & Explanations

5 (*c*) Option (c) is incorrect for the given experimental set. It can be corrected as

The solution flows down the tube and returns to the reservoir due to gravity not suction pressure. A pump circulates the nutrient solution from a reservoir to the elevated end of the tube.

Rest all options are correct.

6 (*b*) In hydroponics, the nutrient solution must be adequately aerated in order to obtain optimum growth, because roots respire aerobically. Thus, if proper aeration is not provided, the plant can die.

11 (*a*) Aeroponics is similar to hydroponics in a way that it involves growing plants in air or moist environment without the use of soil or an aggregate medium.

14 (*c*) The techniques available can detect the presence of an element at a concentration which is as low as 10^{-8} g/mL.

16 (*b*) An essential element is the one which is indispensable for the growth of plants and cannot be replaced by any other element. Absence/deficiency of these elements produces disorders/malfunctioning at the cellular level.

18 (*c*) Nitrogen, sulphur and phosphorus are all macronutrients. Among the other options given, Mg is also a macronutrient. Micronutrients include Fe, Cu, Mo, Mn, Bo, Zn, etc.

19 (*b*) Magnesium (Mg) is a macronutrient and not a micronutrient. Such nutrients (macronutrient) are required by plants in comparatively large amounts (1-10 mg per gram of dry matter or m mole kg^{-1} of dry weight).

Other examples of macronutrient are phosphorus (P), potassium (K), nitrogen (N), etc.

Micronutrients are required by plant in traces, less than 0.1 mg per g of dry matter, e.g. boron (B), zinc (Zn) and manganese (Mn) are micronutrients.

20 (*a*) Minerals known to be required in large amounts for plant growth are macronutrients, i.e. phosphorus, potassium, sulphur, calcium.

21 (*d*) Potassium (K) is not considered as trace element or a micronutrient for plants. The essential elements, which are required in traces, i.e. mg/g of dry matter by the plants are called micronutrients or trace elements. These are eight in number Zn, Mn, B, Cu, Mo, Fe, Ni and Cl. K is a macronutrient.

27 (*a*) Magnesium is the essential element that is considered as the component of energy related chemical compound in plants chlorophyll. It presents at the centre of the porphyrin ring structure of chlorophyll molecule.

28 (*d*) Essential elements act as activators or inhibitors of enzymes. For example, Mg^{2+} is an activator of both RuBisCO and PEP carboxylase enzymes, both of which are critical photosynthetic carbon fixation.

Zn^{2+} is an activator of alcohol dehydrogenase. Mo of nitrogenase enzyme during nitrogen metabolism.

29 (*a*) Nitrogen is the mineral element, which is required by plants in the greatest amount. It is required by all the parts of a plant for the synthesis of amino acids and nucleic acids and serves as a major constituent of nucleic acids, proteins, vitamins and hormones.

30 (*d*) Nitrogen is absorbed by the plants mainly as NO_3^- nitrates though some amount is also taken up as NH_4^+ or NO_2^-.

31 (*d*) In plants, nitrogen is required mainly by the meristematic tissues and the metabolically active cells. It is because these cells are in the process of synthesising new biomolecules of the protoplasts to grow.

32 (*b*) Nitrogen serves as the major constituent of chlorophyll, several hormones, vitamins and amino acids and proteins.

33 (*d*) Phosphorus is absorbed by the plants from soil in the form of phosphate ions, either as $H_2PO_4^-$ or HPO_4^{2-}.

34 (*d*) Phosphorus is not a structural element of carbohydrate. It is present in nucleotide (purine and pyrimidine) which are the building blocks for nucleic acid, synthesis ATP (an energy source) and proteins.

35 (*d*) In plants, potassium is required in more abundant quantities in the meristematic tissues, buds, leaves and root tips. It is absorbed as K^+ ion.

36 (*a*) Out of the given elements, potassium (K^+) is responsible for maintaining turgor pressure in cells because it regulates proton pumps involved in opening and closing of stomata.

37 (*b*) The mineral element which helps in protein synthesis, opening and closing of stomata, activation of enzyme and in maintenance of trugidity of cells is potassium by maintaining an anion-cation balance in cells.

38 (*d*) Ca^{2+} is an essential element for plants. It provides selective permeability to the cell membrane. These are required for the organisation of mitotic spindle. Calcium is also used during cell division, in the synthesis of cell wall, particularly as calcium pectate in the middle lamella. It activates certain enzymes and plays an important role in regulating metabolic activities.

41 (*d*) Sulphur is a constituent of amino acids like cysteine and methionine and is the main constituent of several coenzymes, vitamins and ferredoxin. Plants obtain sulphur in the form of sulphate (SO_4^{2-}).

43 (*d*) Plants absorb iron mostly in the form of ferric (Fe^{3+}) ions. However, plants in acidic soil can also absorb iron in ferrous (Fe^{2+}) as well as ferric (Fe^{3+}) form. It is an important constituent of proteins involved in the transfer of electrons like ferredoxin and cytochromes. It is reversibly oxidised from Fe^{2+} to Fe^{3+} during electron transfer. It activates catalase enzyme. It is essential for the formation of chlorophyll.

45 (*a*) The essential element for the synthesis of auxin is zinc. This plant hormone is produced in the stem tip that promotes cell elongation.

46 (*b*) Minerals involved in redox reactions in plant cells are iron (Fe) and copper (Cu). Fe is an important constituent of proteins which are involved in the transfer of electrons like ferredoxin and cytochromes. It is reversibly oxidised from Fe^{2+} to Fe^{3+} during electron transfer.

Cu is essential for the overall metabolism of plants. Like iron, it is also associated with certain enzymes involved in redox reactions and is reversibly oxidised from Cu^+ to Cu^{2+}.

48 (*a*) Option (a) contains the correct group of three elements which mostly affect both photosynthesis and mitochondrial electron flow. Copper, iron and manganese are associated with enzymes involved in photosynthesis and respiration.

49 (*a*) Magnesium (Mg), phosphorus (P) and nitrogen (N), are the missing elements.

- The elements missing in dish X is magnesium because Mg deficiency causes chlorosis is yellowing of leaves.
- The element missing in dish Y is phosphorus because P deficiency causes the development of purple or red spots on leaves.
- The element missing in dish Z is potassium as its deficiency causes the formation of scorched leaf tip along with chlorosis and necrosis.

50 (*d*) If premature yellowing of leaves of a pulse crop was observed, then the elements like Fe, Mg, N, K, S, Mn and Mo would be the most beneficial treatment. These elements will promote the synthesis of chlorophyll may become most beneficial to overcome the problem and to obtain maximum yield.

51 (*b*) Both manganese and chlorine are essential for the splitting of water during photosynthesis, a reaction that leads to oxygen evolution.

54 (*b*) Etiolation is the symptom developed in plants when they are grown in the dark. It is not caused by deficiency of any mineral in plants.

55 (*a*) Out of the given options, phosphorus causes premature falling of the leaves and flowers. It is a constituent of nucleic acids, proteins, $NADP^+$, etc. Its deficiency causes chlorosis and necrosis. Apart from P, N also causes premature leaf fall.

57 (*a*) Deficiency symptoms of nitrogen (N), potassium (K) and magnesium (Mg) are first visible in senescent (older) leaves, because these are mobile elements.

59 (*b*) The mineral ion concentration in tissues that reduce the dry weight of tissues by about 10% is called toxic concentration. The requirement of micronutrients is always in low amounts, while their moderate decrease causes the deficiency symptoms and a moderate increase causes toxicity.

61 (*a*) In the initial phase of mineral absorption, ions are passively taken up into the outer space or free space of cells through ion channels or transmembrane proteins which act as selective pores.

65 (*d*) Active uptake of ions into the symplast requires the expenditure of metabolic energy, i.e. ATP.

68 (*a*) Movement of ions out of the cell is called efflux, whereas the movement of ions into the cell is called influx.

Both the processes are active processes with the former occurring in plant roots growing in salty area

69 (*b*) The mineral ions absorbed by roots are transported through xylem. The solutes are carried along with the ascending stream of water, which are pulled up through the plants by transpirational pull. Analysis of xylem sap shows the presence of mineral salts in it which can be confirmed by the use of radioisotopes of mineral elements.

74 (*c*) Ammonification is the process by which the organic nitrogen of dead plants and animals is converted to ammonium ions (NH_4) by the action of saprotrophic fungi and bacteria.

75 (*a*) Nitrifying bacteria are those microbes which are capable of converting ammonia present in soil into nitrates (NO_3^-). A few examples are *Nitrosomonas, Nitrobacter*, etc.

76 (*b*) Rhizosphere is the narrow region of soil which is directly influenced by root secretions and is associated with the soil microorganisms.

80 (c) *Thiobacillus denitrificans* and *Pseudomonas denitrificans* reduce nitrate in soil into nitrogen through a process is called denitrification.

On the other hand, *Nitrosomonas* and *Nitrococcus* oxidise ammonia into nitrite. The bacterium, *Nitrobacter* oxidises nitrite to nitrate. These processes together are known as nitrification.

84 (*b*) *Azolla* is added along with *Anabaena* to rice plants (a blue-green algae) which symbiotically fix atmospheric nitrogen to make it available to rice plants.

85 (*a*) *Alnus* is a non-leguminous plant that forms nodules to fix the atmospheric nitrogen with *Frankia*.

88 (*c*) The reduction of nitrogen to ammonia by living organisms is called biological nitrogen-fixation. Certain prokaryotic species are capable of fixing nitrogen due to the presence of nitrogenase enzyme in them.

89 (*a*) Leghaemoglobin is a red coloured pigment found in the root nodules of leguminous plants. It combines with oxygen and thus helps in oxygen removal from root nodules.

91 (*b*) The soil pH greatly and adversely affects the rhizosphere. This also effects the growth and multiplication of nitrogen-fixing bacterium and nodule formation.

93 (*a*) The reaction given in question represents reductive amination. In this process, α-ketoglutaric acid from the Krebs' cycle is converted into glutamate in the presence of coenzyme NADH or NADPH. The reaction occurs in the presence of enzyme glutamate dehydrogenase.

94 (*c*) The given reaction shows transamination. It involves the transfer of amino group from one amino acid to the ketogroup of a ketoacid.

Glutamic acid is the main amino acid from which the transfer of NH_2, the amino group takes place and other amino acids are formed through transamination. The enzyme transaminase catalyses all such reactions.

96 (*c*) Assertion is true, but Reason is false and can be corrected as

Hydroponics is a technique of growing plants in a nutrient solution, i.e. with soil. With the help of hydroponics essential elements and their deficiency symptoms can be identified.

97 (*c*) Assertion is true, but Reason is false and can be corrected as

It hydroponics, due to the exposure of plant roots to a limited amount of the solution, there are chances that the concentrations of oxygen and other minerals would reduce. Thus, a continuous supply of purified water and nutrient salts is always essential.

98 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

Cold nutrient solution is better than warm nutrient solution for hydroponics.

The temperature required for hydroponics nutrient solution should be 68-72°F (18-26°C). Cold water is capable of holding more dissolved oxygen than warm water.

99 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Some essential elements can alter the osmotic potential of a cell, e.g. potassium plays an important role in regulating the osmotic potential in plants by facilitating the opening and closing of stomata.

100 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Manganese plays an important role in nitrate reduction. It acts as an activator of the enzymes nitrite reductase and hydroxylamine reductase which are involved in the process of nitrate reduction.

101 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

Magnesium is a constituent of the ring structure of chlorophyll, the pigment which in the presence of sunlight performs photosynthesis in the chloroplast to produce sugar (carbohydrate).

Thus, magnesium is important in photosynthesis and carbohydrate metabolism. Mg^{2+} are also involved in the synthesis of nucleic acids, i.e. DNA and RNA.

102 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Active absorption requires energy for absorption of minerals. This energy comes from aerobic respiration.

Thus, when the roots are deprived of oxygen, active absorption of minerals is inhibited.

103 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Leguminous plants have nodulated roots to which *Rhizobium* is symbiotically associated making N_2 available to the plants. Hence, leguminous plants are symbiotic nitrogen fixers.

104 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

Nitrogen-fixing bacteria *Rhizobium* is a free-living aerobic bacteria symbiotically associated with the roots of leguminous plants. The enzyme nitrogenase required during nitrogen-fixation is highly sensitive to the molecular oxygen and it requires anaerobic conditions. The nodules have adaptation that ensure the enzyme is protected from oxygen. To protect these enzymes, the nodule contains oxygen scavengers called leghaemoglobin.

So, the bacteria or microbes that live as aerobes under free-living conditions (where nitrogenase is not operational), become anaerobic (thus protecting the operational nitrogenase enzyme).

105 (*c*) The statement in option (c) is correct. Rest incorrect statements can be corrected as

- Minerals present in the soil enter into the plant through absorption by roots.
- Gold can be accumulated by plants.
- Minerals even at a very low concentration (10^{-8} g/mL) can be easily detected by various techniques.

106 (*c*) The statement in option (c) is incorrect and can be corrected as

Essential elements are those elements which are always directly involved in the metabolism of the plant.

Rest of the statements are correct.

107 (*b*) Statement in option (b) is incorrect and can be corrected as

The enzyme nitrogenase is highly sensitive to the presence of molecular oxygen.

Rest of the statements are correct.

109 (*c*) Statement II is incorrect. It can be corrected as Hydroponics requires purified water with well-defined mineral nutrient salts in the culture solution.

Statements I, III and IV are correct.

110 (*b*) Statements I and II are correct. Statements III and IV are incorrect and can be corrected as

- Hydroponics is an expensive process and does not reduce labour cost.
- It does not increase the problem of weeding because hydroponics is a soil-free culture technique.

113 (*b*) The statements mentioned in the question are the characteristics of the essential element Fe. It activates catalase enzyme and is essential for the formation of chlorophyll. It is an important constituent of proteins involved in the transfer of electrons like ferredoxin and cytochromes. It is reversibly oxidised from Fe^{2+} to Fe^{3+} during electron transfer, in photosynthesis and respiration.

114 (*b*) Statements I, II and IV are true, but only statement III is false. It can be corrected as

Chlorine is required for photolysis of water.

118 (*c*) Statements I and IV are correct, but statements II and III are incorrect and can be corrected as

- The concentration of the essential element below which plant growth is retarded is termed as critical concentration.
- Deficiency symptoms are the morphological changes that are indicative of certain element deficiencies, e.g. chlorosis, necrosis, etc.

119 (*a*) Statements I, II and III are correct. Statement IV is incorrect and can be corrected as

Formation of ammonia is a reducing process.

120 (*d*) Statements II and III are correct and statement I is incorrect. It can be corrected as

The central portion of root nodule of leguminous plant is pink due to the presence of iron (Fe) element in the protein leghaemoglobin.

128 (*d*) Both options (a) and (c) are correct and can be explained as

Impure water contains a large number of soluble minerals dissolved in it. Likewise, the salts also contain impurities. If such impure water and mineral salts are used as culture solution for growing plants in hydroponics, these impurities hinder with the experiments used for detection of essentiality of an element.

As a result, use of purified water and mineral/nutrient salts is done in studies involving mineral nutrition using hydroponics to remove impurities from the culture medium which will thereby speed up the process.

129 (*c*) The deficiency symptoms tend to appear first in the younger tissues when the element involved is immobile. In case of elements that are actively mobilise within the plants the deficiency symptoms tend to appear first in older tissues.

130 (*b*) Changing the soil chemistry is not a role of any essential element. The remaining statements are the characteristics of an essential element. These elements are directly involved in the metabolism of plants.

131 (*a*) The statement given in option (a) best explains the term critical concentration of an essential element.

It is defined as the concentration below which plant growth retarded. plants start showing deficiency symptoms if a particular element is present in soil below the critical concentration.

132 (*a*) When deficiency symptoms appear first in young leaves and young tissues of a plant the element involved is said to be relatively immobile inside the plant, e.g. sulphur and calcium.

The parts of the plants that show deficiency symptoms depend on the mobility of the element in the plant. These parts of the structural component of the cell and hence are not easily released.

The deficiency symptoms appear first in old leaves and tissues for those elements which are mobilised from senescing regions for supply to young tissues, e.g. N, K, Mg.

133 (*a*) The statement in option (a) does not hold true for biological nitrogen-fixation by *Rhizobium* in association with soyabean. It can be corrected as

The enzyme nitrogenase, which is capable of nitrogen reduction is present exclusively in prokaryotes (e.g. *Rhizobium*). It is highly sensitive to O_2 and gets inactivated when exposed to it and thus does not require oxygen for its functioning.

Rest of the statements are true.

134 (*d*) The statement in option (d) is not true about the given equations and can be corrected as

The bacteria involved in the process are not photoautotrophs, but are chemoautotrophs. These bacteria oxidise inorganic substances like NH_3 and NO_2 and use the released energy, hence they are called chemoautotrophs.

Simultaneously, they help in the conversion of ammonia (NH_3) to absorbable form (NO_2^- and NO_3^-) of nitrogen.

Rest of the statements are correct.

135 (*b*) The symptom given in option (b) is not due to Mn toxicity in plants. It can be corrected as

The prominent symptom of manganese (Mn) toxicity is the appearance of brown spot surrounded by chlorotic veins. Mn competes with iron and magnesium for uptake and with magnesium for binding with enzymes. Mn also inhibits Ca translocated in shoot apex. Further, excess of Mn induces deficiencies of iron, magnesium and calcium, but not nitrogen.

137 (*d*) The statement in option (d) is incorrect. It can be corrected as

Plants cannot be grown in water or soil without essential nutrients. The plants can be grown in any medium either water or soil, if it is supported with all essential elements. Medium does not affect the plant growth, but availability of all elements does affect the growth of plants.