
Fundamentals of Plant Biochemistry

Objectives and Keynotes/Short Explanations

(As per New ICAR Syllabus)

For ready reference to the students, teachers, researchers and aspirants of various competitive examinations, exclusively for JRF, SRF, ICAR-ARS/NET, M. Sc and Ph. D examinations

This First Edition published in 2025

© 2025 New Delhi Publishers, India

**Title: Fundamentals of Plant Biochemistry - Objectives and Keynotes/
Short Explanations**

Author: Dr. Sanjoy Shil

Description: First edition | New Delhi Publishers 2025 | Includes bibliographical references and index.

Identifiers: ISBN 9788197860331 (Print) | 9788197860386 (eBook)

Cover Design: New Delhi Publishers

All rights reserved. No part of this publication or the information contained herein may be reproduced, adapted, abridged, translated, stored in a retrieval system, computer system, photographic or other systems or transmitted in any form or by any means, electronic, mechanical, by photocopying, recording or otherwise, without written prior permission from the publisher.

Disclaimer: Whereas every effort has been made to avoid errors and omissions, this publication is being sold on the understanding that neither the editors (or authors) nor the publishers nor the printers would be liable in any manner to any person either for an error or for an omission in this publication, or for any action to be taken on the basis of this work. Any inadvertent discrepancy noted may be brought to the attention of the publisher, for rectifying it in future editions, if published.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe



NEW DELHI PUBLISHERS

Head Office: 90, Sainik Vihar, Mohan Garden, New Delhi, India

Corporate Office: 7/28, Room No. 208/209, Vardaan House, Mahavir Lane, Ansari Road, Daryaganj, New Delhi, India

Branch Office: 216, Flat-GC, Green Park, Narendrapur, Kolkata, India

Tel: 011-23256188, 011-45130562, 9971676330, 9582248909

Email: ndpublishers@gmail.com

Website: www.ndpublisher.in

Fundamentals of Plant Biochemistry

Objectives and Keynotes/Short Explanations

[For Agriculture Students as per New ICAR Syllabus]



Dr. Sanjoy Shil

M.Sc (Ag.), Ph.D

Assistant Professor

(Plant Physiology/Agril. Biochemistry/Microbiology)

Bidhan Chandra Krishi Viswavidyalaya (Bankura Campus)

Susunia, Chhatna, Bankura 722132, West Bengal



NEW DELHI PUBLISHERS

New Delhi, Kolkata

Preface

In modern agriculture, Plant biochemistry plays a pivotal role in improving crop production and productivity in respect to quality etc. Biochemistry has emerged as an exciting area of plant sciences by creating unprecedented opportunities for manipulation of all biological systems. The present book “**Fundamentals of Plant Biochemistry**” has been designed to fulfill the course requirements for the UG students in their 2nd semester as per the recommendation of 5th Dean’s Committee Report. Students might have to solve various objective questions in their university examinations and various competitive examinations as well as they also develop their basic concept on different topics as discussed in keynotes chapter. This book explains the topics in a simple language and lucid manner. It also meet the specific needs for the students of Post-Graduate students of Agricultural Science as well as Biological Science and also the candidates appearing for various competitive examinations like JRF, SRF, ARS/NET, SAU Exam etc. This book comprehends a lot of objective questions (Chapter wise) that followed by the new syllabus of ICAR as well as discussed the sufficient terminology relevant to Plant biochemistry.

This book comprises twenty chapters that cover every topics accompanied by their answers at the end of every chapter and explain all the keynotes in descriptive manner. It is hoped that through this book; the students, teachers and scientists can able to share with the excitement, mystery and challenge of learning about the plant biochemistry. Any suggestions, comments or healthy criticism to further up gradation of the book or addition/deletion etc are heartily invited and most appreciable that may give an opportunity to remove the short-comings.

It is a great privilege to acknowledge with the praises to God and convey my special and sincere regards are due to my beloved parents

Shri. Rabindra Kumar Shil and Smt. Maya Shil who share each and every achievement made by me and to whom I am very much indebted. This is also an immense pleasure to express my deep gratitude and deep sense of whole-hearted love to my wife Tithi Shil Majumder and daughter Sreemoyee and Sushmoyee for their immense help, guidance, encouragement and untiring moral support ever and always in bringing out this book.

I must thankful to New Delhi Publishers for their help in bringing out this publication in a presentable form. I would definitely like to express my gratefulness to all those who have directly or indirectly forward their helping hands in full completion of this book.

Last but not the least, I once again remarkably acknowledges the gratefulness to all of you.

Place: BCKV (Bankura Campus), Susunia, W.B.

Date: June, 2024.

Dr. Sanjoy Shil

Syllabus

Fundamentals of Plant Biochemistry

Course credit: 3 (2L+1P)

Theory

Importance of Biochemistry, Properties of Water, pH and Buffer. Carbohydrate: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Polysaccharides. Lipid: Importance and classification; Structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: Importance of proteins and classification; Structures, titration and zwitterions nature of amino acids; Structural organization of proteins. Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes. Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

Practical

Preparation of solution, pH & buffers, Qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids, Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides.

Dedicated to

*My respected parents,
beloved wife and
affectionate daughters*

Dr. Sanjoy Shil

Contents

<i>Preface</i>	v
<i>Syllabus</i>	vii
<i>Abbreviations</i>	xiii
1. Plant Biochemistry – Introduction and Importance in Agriculture	1
2. Chemistry and Properties of Water, pH and Buffer	13
3. Carbohydrate - Importance, Classification, Properties and Structure	25
4. Carbohydrate Metabolism	59
5. Amino Acids & Proteins – Importance, Classification, Properties and Structural Organization	89
6. Enzymes - Properties, Classification, Mechanism of Action, Equations and Plots, Specificity, Cofactors, Apoenzyme & Coenzymes, Isozymes, Inhibition, Effects of Enzymatic Reaction and Allosteric Enzymes	141
7. Lipid - Importance, Classification, Structure and Properties	183
8. Lipid Metabolism - Biosynthesis and Degradation	233
9. Nucleic Acids - Introduction, Importance, Classification, Structure, Types and Chemistry	275
10. Secondary Plant Metabolites – Terpenoids, Alkaloids and Phenolics	351

11. Keynotes/Short Explanations on Plant Biochemistry - Introduction & Importance in Agriculture	373
12. Keynotes/Short Explanations on Chemistry and Properties of Water, pH and Buffer	379
13. Keynotes/Short Explanations on Carbohydrate - Importance, Classification, Structure and Properties	387
14. Keynotes/Short Explanations on Carbohydrate Metabolism	403
15. Keynotes/Short Explanations on Amino Acids & Proteins - Importance, Classification, Properties and Structural Organization	423
16. Keynotes/Short Explanations on Enzymes - Properties, Classification, Mechanism of Action, Equations and Plots, Specificity, Cofactors, Apoenzymes & Coenzymes, Isozymes, Inhibition, Effects of Enzymatic Reaction and Allosteric Enzymes	441
17. Keynotes/Short Explanations on Lipid - Importance, Classification, Structure and Properties	461
18. Keynotes/Short Explanations on Lipid Metabolism - Biosynthesis and Degradation	471
19. Keynotes/Short Explanations on Nucleic Acids - Importance, Classification, Structure, Chemistry and Types	475
20. Keynotes/Short Explanations on Secondary Plant Metabolites – Terpenoids, Alkaloids and Phenolics	489
21. Further Readings	501

Abbreviations

2,4,5-T	: 2,4,5-trichlorophenoxy acetic acid
2,4-D	: 2,4-dichlorophenoxy acetic acid
AAS	: Atomic absorption spectrophotometer
ABA	: Abscisic acid
CC	: 1-aminocyclopropane 1-carboxylic acid
ACP	: Acyl carrier protein
ADP	: Adenosine diphosphate
AFLP	: Amplified fragment length polymorphism
AIDS	: Acquired immune deficiency syndrome
ALA	: δ -aminolevulinic acid
AAMP	: Adenosine 5'-monophosphate
AMP	: Adenosine monophosphate
AOA	: Aminoxyacetic acid
APS	: Adenosine-5' -phosphosulphate
ATP	: Adenosine triphosphate
ATPase	: An enzyme that hydrolyses ATP
AVG	: Aminoethoxy vinyl glycine
BA	: Benzyladenine
BCCP	: Biotin carboxyl carrier protein
BOAA	: β -N-Oxyl amino-L-alanine
Bp	: Base pairs
CAC	: Citric acid cycle
AMP	: 3',5' -cyclic adenosine monophosphate
cDNA	: Complementary deoxyribonucleic acid
CMP	: Cytidine mono phosphate
CMU	: 3-4' Chlorophenyl -1, 1- dimethyl urea

CoA	: Coenzyme A
CoA	: Coenzyme A
CoASH	: Coenzyme A (CoA) synthetase
Complex I	: NADH-ubiquinone oxidoreductase or NADH dehydrogenase
cComplex II	: Succinate dehydrogenase
Complex III	: Cytochrome bc ₁ complex or ubiquinone : cytochrome c oxidoreductase
Complex IV	: Cytochrome oxidase
COP	: Cytidine diphosphate
CPPP	: Cyclopentanoperhydrophenanthrene
CTAB	: Cetyl trimethyl ammonium bromide
CTP	: Cytidine 5' -triphosphate
Cyt	: Cytochrome
dA	: Deoxyadenosine
DAF	: DNA amplification fingerprint
DAG	: Diacylglycerol
dC	: Deoxycytosine
DCCD	: Dicyclohexylcarbodiimide (inhibitor of ATP synthase)
DCMU	: 3-(3,4-Dichlorophenyl)-1,1- dimethyl urea
dG	: Deoxyguanosine
DGDG	: Digalactosyl diacylglycerol
DHA	: Docosahexaenoic acid
DHAP	: Dihydroxy acetone phosphate
DHAP	: Dihydroxy acetone phosphate
DMAPP	: Dimethylallyl pyrophosphate
DMSO	: Dimethyl sulphoxide
DNA	: Deoxyribonucleic acid

DNP	: 2,4-Dinitrophenol (an uncoupler)
DP	: Degree of polymerization
dT	: Deoxythymine
DUP	: Digestible undegradable protein
E. number	: Enzyme commission number
EDTA	: Ethylene diamine tetraacetic acid
EFA	: Essential fatty acid
ELISA	: Enzyme linked immunosorbant assay
EMP	: Embden-Meyerhof- Parnas pathway
EPA	: Eicosapentaenoic acid
EPSP	: Synthase 5-enolpyruvylshikimic acid 3-phosphate synthase
ER	: Endoplasmic reticulum
ES complex	: Enzyme-Substrate complex
ES	: Enzyme-substrate complex
FAD	: Flavin adenine dinucleotide
FAD	: Flavin adenine dinucleotide (oxidized)
FADH ₂	: Flavin adenine dinucleotide (reduced)
FCCP	: Carbonyl cyanide p-(trifluoromethoxy) phenylhydrazone (uncoupler)
Fd/FdH ₂	: Ferredoxin (oxidized and reduced forms)
FDA	: Fluorescein diacetate
FDNB	: Fluoro dinitro benzene (Sanger's reagent)
FMN	: Flavin mononucleotide
FMN	: Flavin mononucleotide (oxidized)
FMNH ₂	: Flavin mononucleotide (reduced)
FPP	: Farnesyl pyrophosphate
GA	: Gibberellic acid
GBSS	: Granulosis bound starch

GDP	: Guanosine diphosphate
GDP	: Guanosine triphosphate
GLC	: Gas liquid chromatography
GMP	: Guanosine-5' -monophosphate
GOGAT	: Glutamate synthase
GOP	: Guanosine diphosphate
GS	: Glutamine synthetase
GTP	: Guanosine triphosphate
HDL	: High density lipoprotein
HMG-CoA	: Hydroxymethylglutaryl coenzyme A
HMP shunt	: Hexose monophosphate shunt
hnRNA	: heterogeneous nuclear ribonucleic acid
HPLC	: High performance liquid chromatography
HPLC	: High performance liquid chromatography
IBA	: Indole butyric acid
IMP	: Inosine monophosphate
IPP	: Iopentenyl pyrophosphate
ISSR	: Inter simple sequence repeats
IUB	: International Union of Biochemistry
kcal/mol	: kilocalories per mole
kJ/mol	: kilojoules per mole
K _m	: Michaelis constant
K _m	: Michaelis-Menten Constant
LDH	: Lactate dehydrogenase
LDH	: Lactate dehydrogenase
LDL	: Low density lipoprotein
LHC	: Light-harvesting complex
LOS	: Low oxygen storage
LPS	: Low pressure storage

MAS	: Marker assisted selection
MGDG	: Monogalactosyldiacylglycerol
miRNAs	: Micro RNAs
mRNA	: Messenger ribonucleic acid
MSG	: Monosodium glutamate
NAA	: α -naphthalene acetic acid
NAD	: Nicotine adenine dinucleotide (oxidized)
NADH	: Nicotine adenine dinucleotide (reduced)
NADP	: Nicotine adenine dinucleotide phosphate (oxidized)
NADPH	: Nicotine adenine dinucleotide phosphate (reduced)
NEFA	: Non-esterified fatty acid
NPN	: Non-protein nitrogen
OAA	: Oxaloacetic acid
OSA	: Oxalosuccinic acid
PA	: Phosphatidic acid
PABA	: p-aminobenzoic acid
PABA	: Para amino benzoic acid
PAGE	: Polyacrylamide gel electrophoresis
PAL	: Phenylalanine ammonia lyase
PC	: Phosphatidylcholine
Pc	: Plastocyanin
PC	: Plastocyanin
PCR	: Polymerase chain reaction
PDH	: Pyruvate dehydrogenase
PE	: Phosphatidylethanolamine
PEG	: Polyethylene glycol
PEO	: Polyethylene oxide

PEP	:	Phosphoenol pyruvate
PEP	:	Phosphoenolpyruvate
PFK	:	Phosphofructokinase
PFK ₁	:	Phosphofructokinase 1
PFK ₂	:	Phosphofructokinase 2
PG	:	Phosphatidylglycerol
PGA	:	Phosphoglyceric acid
PGALD	:	Phosphoglyceraldehyde
PGR	:	Plant growth regulator
PI	:	Phosphatidylinositol
PITC	:	Phenyl isothiocyanate (Edman's reagent)
P _j	:	Orthophosphate
PME	:	Pectin methylesterase
PMF	:	Proton motive force
PMF	:	Proton-motive force
PP _j	:	Pyrophosphate
PPP	:	Pentose phosphate pathway
P _q	:	Plastoquinone
PQ	:	Plastoquinone
PRPP	:	Phosphoribosyl pyrophosphate
PS	:	Phosphatidylserine
PTH	:	Phenyl thiohydantoin
PUFA	:	Polyunsaturated fatty acid
PUFAs	:	Polyunsaturated fatty acids
PV	:	Peroxide value
QTL	:	Quantitative trait loci
R.M. number	:	Reichert-Meisel number
R.Q	:	Respiratory Quotient
RAPD	:	Randomly amplified polymorphic DNA

RE	: Restriction endonuclease
RET	: Resonance energy transfer
RF	: Retention factor
RFLP	: Restriction fragment length polymorphism
RFLP	: Restriction-fragment length polymorphism
RIA	: Radioimmunoassay
RNA	: Ribonucleic acid
ROS	: Reactive oxygen species
rRNA	: Ribosomal ribonucleic acid
Rubisco	: Ribulose-1, 5-bisphosphate carboxylase/ oxygenase
S	: Svedberg unit
SAM	: S-adenosylmethionine
SDS	: Sodium Dodecyl sulphate
-SH	: Sulfhydryl group
SMCO	: S-methyl cysteine sulfoxide
SNP	: Single nucleotide polymorphism
snRNP	: Small nuclear ribonuclear particle
S-S linkage	: Disulphide linkage
SSB proteins	: Single stranded binding proteins
SSLP	: Simple sequence length polymorphism
SSR	: Microsatellites or Single sequence repeat
SSS	: Soluble starch synthase
STR	: Short tandem repeat
TCA	: Cycle tricarboxylic acid cycle
TCA	: Tricarboxylic acid cycle
TLC	: Thin layer chromatography
TMP	: Thymidine 5'-monophosphate
TPP	: Thiamin pyrophosphate

TPP	:	Thymine pyrophosphate
tRNA	:	Transfer ribonucleic acid
TSS	:	Total soluble sugar
TST	:	Transition state theory
TTC	:	Triphenyl tetrazolium chloride
UDP	:	Uridine diphosphate
UDPG	:	Uridine diphosphate glucose
UMP	:	Uridine monophosphate
UQ	:	Ubiquinone
UTP	:	Uridine triphosphate
UV	:	Ultraviolet
VFA	:	Volatile fatty acid
VLDL	:	Very low density lipoprotein
