Glucose Metabolism

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Abstract

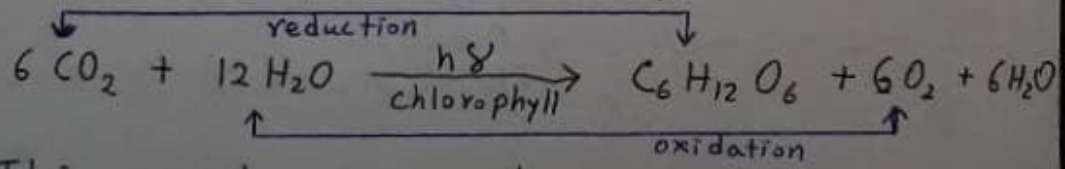
Glucose metabolism refers to the synthesis of glucose in plants (green plants) or produces and breakdown of its in consumers to produce ATP (energy). In this piece of analysis, we are going to discuss photosynthetic production of glucose and its breakdown by the process of cellular respiration.

Objective

To understand the process of synthesis and breakdown of glucose.

Introduction

The process of formation of glucose in chlorophyllated plants is called Photosynthesis. (the term is 1st proposed by Barnes). It refers to a physiological process by which chlorophyllated plants prepare simple food (glucose) with the help of sun light and water



⊛This is redox reaction ⊛It is an endergonic reaction as light is trapped into as glucose as potential energy ⊛It is an anabolic process as it results in increase in dry weight of the cell ⊛ Carbon assimilation takes place as C from

gas CO_2 is assimilated as C in glucose by photosynthesis.
Raw materials required are CO_2, H_2O, Sunlight.

PHOTOSYNTHETIC PROCESS

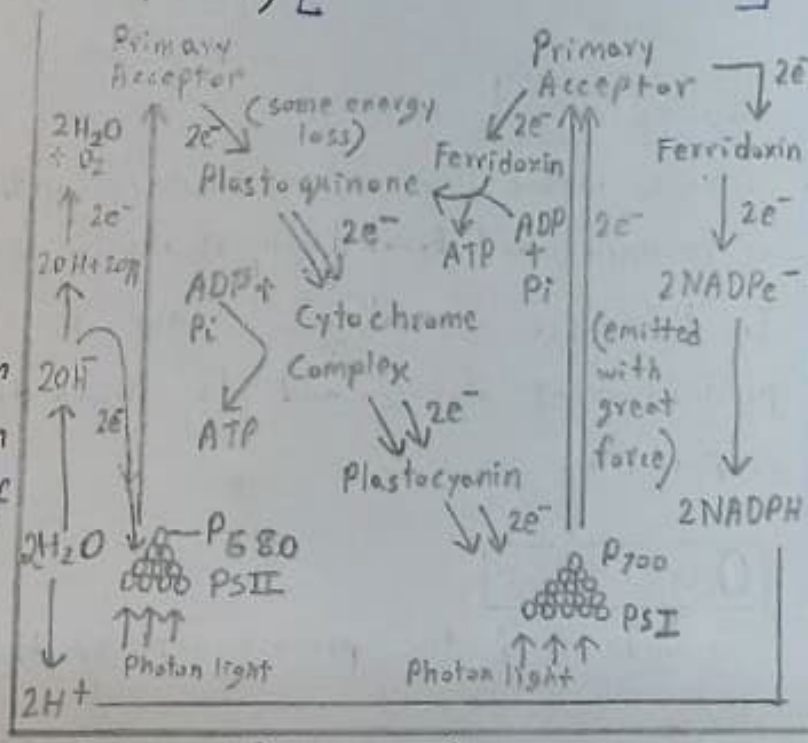
a) Light Phase :- (Light dependent phase as light is directly utilized in the reaction)

Venue :- Grana of chloroplast of quantasomes.

→ The pigments collectively form photosystem I and II (also called Light Harvesting Complex (LHC)).

Z-scheme (Non-Cyclic Photophosphorylation) [According to Hill and Bendal]

In P I, reaction centre is P_{700}. (chlorophyll a), P_{700} absorb 700 nm wavelength of light. In PS II, reaction centre is P_{680}. P_{680} can absorb maximum of 680 nm wavelength of light. The reaction centre emit electron from outer orbit by taking energy from light. Only PS II can perform photolysis of H_2O.



NADP - Nicotinamide Adenine Dinucleotide Phosphate

4OH formed due to continuous process. Electron deficiency in PSI is removed by electron from Plastocyanin. Electron deficiency in PS II is removed by OH^- to form 4OH. PSI has more pigments than PS II.

b) Dark Phase :- (Light Independent Phase)

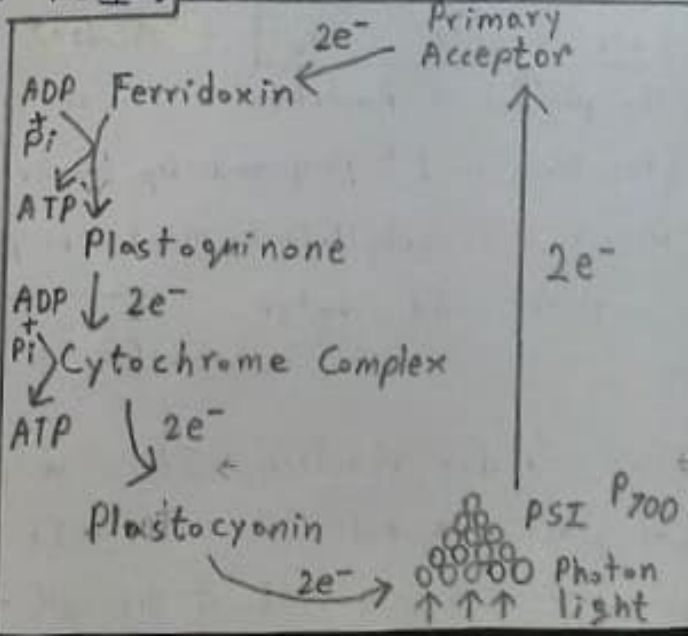
Venue :- Stroma of chloroplast of quantasomes.

→ Absorption of CO_2 for Carbon assimilations

C - C - C - C - C → Ribulose bisphosphate (RuBP)
(P) (P)

Full Forms :- DPOB - Diphospho Orbital ; PGA - 3-Phosphoglyceric Acid ; BGPA - 1,3-Bisphosphoglyceric Acid ; PG Ald - Phospho Galycer Aldehyde

Cyclic Photophosphorylation



DHAP – Dihydroxy Acetone ; F-1,6-BP – Fructose 1,6-Bisphosphate ; G-6-P – Glucose 6 Phosphate ; UTP – Uridine Triphosphate ; UDPG – Uridine Diphosphate Glucose ; PP – Pyrophosphate

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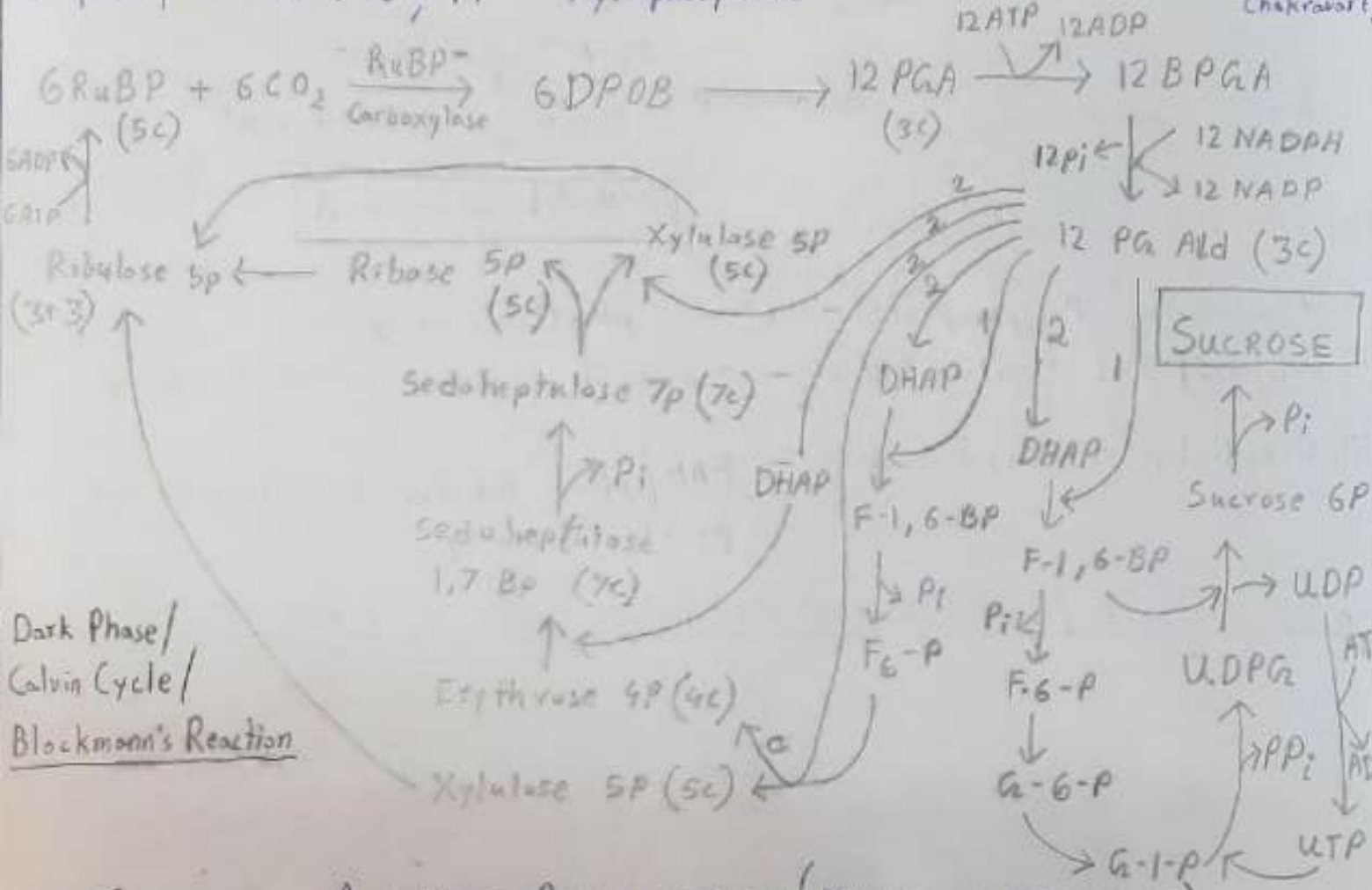
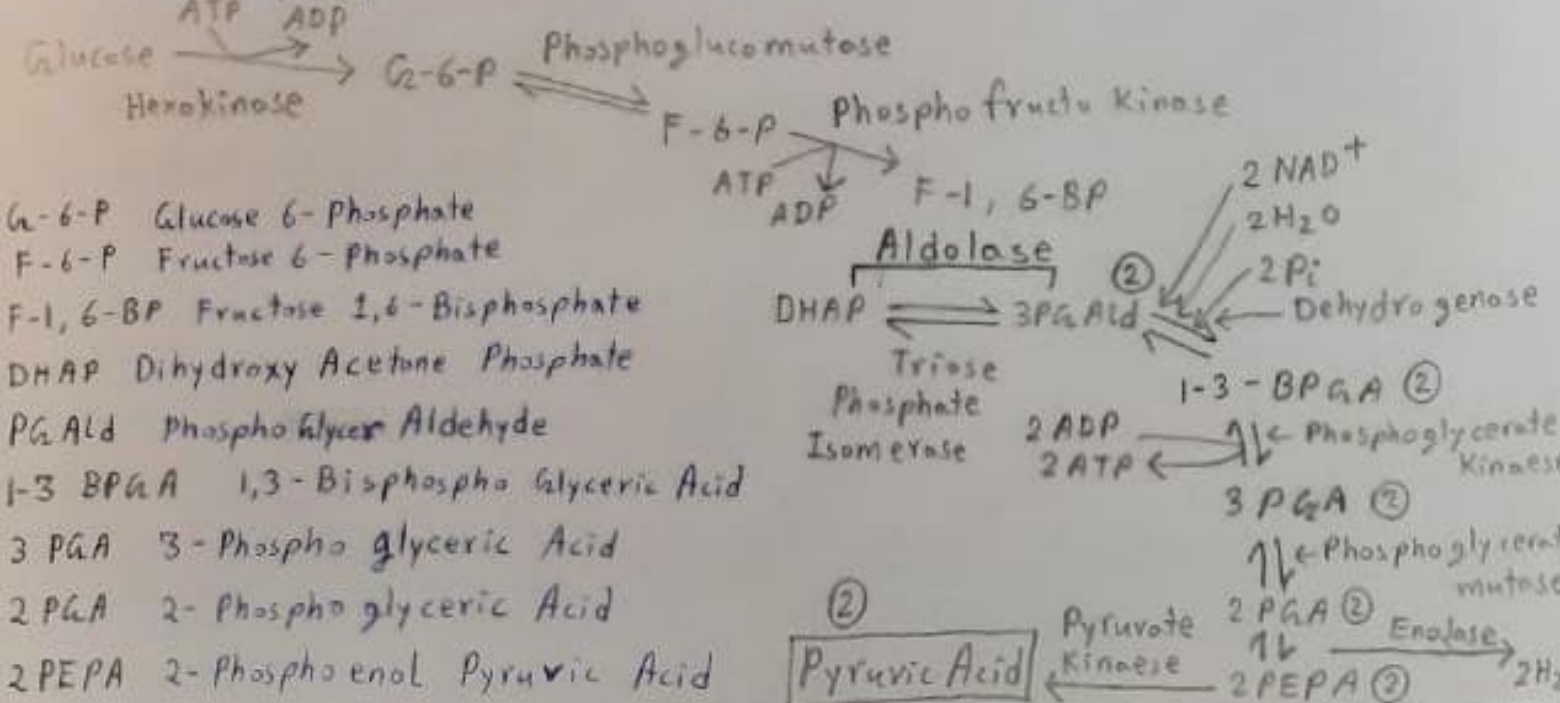


CELLULAR AEROBIC RESPIRATION (BREAKDOWN OF GLUCOSE)

It can be sub-divided into 4 parts - Glycolysis, Oxidative decarboxylation of Pyruvic Acid, Kreb's cycle and ETS (Electron Transport System)

Glycolysis /EMP/ Embdens Meyerhof and Parnas Pathway



G-6-P Glucose 6-Phosphate
F-6-P Fructose 6-Phosphate
F-1,6-BP Fructose 1,6-Bisphosphate
DHAP Dihydroxy Acetone Phosphate
PGAld Phospho Glycer Aldehyde
1-3 BPGA 1,3-Bisphospho Glyceric Acid
3 PGA 3-Phospho glyceric Acid
2 PGA 2-Phospho glyceric Acid
2 PEPA 2-Phospho enol Pyruvic Acid

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Oxidative decarboxylation of Pyruvic Acid

2 Pyruvic Acid (Cytoplasm) —Pyruvate Dehydrogenase System (3-enzyme) in mitochondria→ $2CH_3COCOOH$ (mitochondria)

$2CH_3COCOOH$ + 2CoA → (decarboxylation) $2CO_2$ + $2NADH + H^+$ (oxidative) → 2-Acetyl Coenzyme A

CoA - Coenzyme A

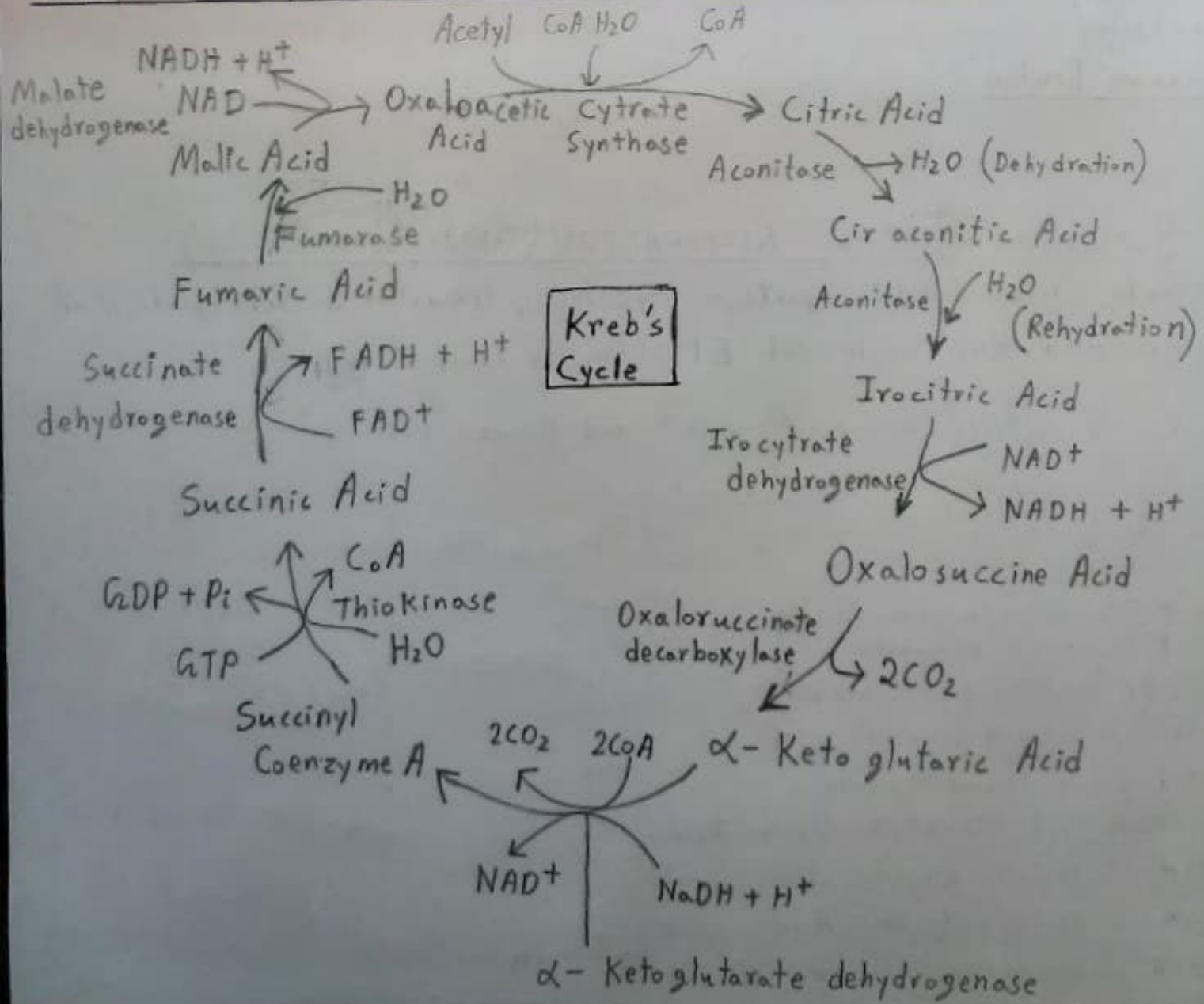
Pyruvate Dehydrogenase System

i) TPP / Thiamine Pyrophosphate – acts as prosthetic group.

ii) Dihydrolipoyl transacetylase – Lipoamide acts as prosthetic group (Non-protein part of enzyme)

iii) Dihydrolipoyl dehydrogenase – FAD / Flavin Adenine Dinucleotide acts as prosthetic group.

Kreb's Cycle / TCAC / Tricarboxylic Acid Cycle / Citric Acid Cycle



Note:- For one molecule of glucose, the Kreb's cycle has to be completed twice as there are 2 molecules of Acetyl Coenzyme A formed by Oxidative decarboxylation of 2 molecules of Pyruvic Acid, which is formed by 1 glucose molecule.

CONCLUSION

There is another process left after Kreb's Cycle called the Electron Transport System (ETS), which acts as electron carriers. It is located in inner mitochondrial membrane and contains a series of coenzymes and cytochromes. Specifically, it occurs in a structure called Oxysome situated on Cristae on inner walls of mitochondria. The specific phenomenon that is known as Kameo Osmotic Theory and it was discovered by Peter Michael. The Respiratory Coenzyme complexes required are Complex I: NADH dehydrogenase, Complex II: Succinate dehydrogenase, Complex III: Cytochrome b, c_1, Complex IV: Cytochrome a and a_3. In a case of cyanide poisoning or carbon monoxide poisoning, this Cyt. a_3 gets inhibited and that causes lower breakdown. During Kreb's Cycle, all the enzymes except Succinate Dehydrogenase are formed in Cytoplasm of cell but this enzyme is found in Mitochondrial Membrane.

Here, only one type of Respiration given, but other type is Anaerobic Respiration, where only Glycolysis is the step which generates 8 ATP. The processes and their production step are (ATP):- Glycolysis - 8ATP, Oxidative Decarboxylation of Pyrivate - 6ATP and Kreb's Cycle - 24 ATP. Total it gives 38 ATP.

REFERENCE

i) Modern ABC + Biology, Nytra Publications

ii) Molecular Biology of Cell by Bruce Alberts (5TH Edition)

iii) SRIJAN ISC BIOLOGY

iv) Class Notes provided by Prof. ARD