

Preface

Existence of life on the Earth is supported by photosynthetic organisms which provide production of organic substances and oxygen evolution. In general, photosynthesis includes primary light reactions and secondary dark reactions. Light reactions begin with absorption of photons by light harvesting photosynthetic pigments, resulting in the formation of their singlet excited states. This process is followed by excitation energy transfer from one pigment molecule to the other. Then, charge separation occurs in the photosynthetic reaction centers. Excited electrons are transferred via the photosynthetic electron transport chain (ETC), providing production of the reducing power in the form of reduced nicotinamide adenine dinucleotide phosphate (NADPH). In anoxygenic phototrophs, external hydrogen compounds are a source of the electrons, and the light is absorbed in a single photosystem. The ETC of oxygenic photosynthetics contains two photochemical systems – PS II (water-plastoquinone oxido-reductase) and PS I (plastocyanin-ferredoxin oxido-reductase) – which transfer electrons from water to NADP, using one more complex, the cytochrome-*b6f*-complex. The source of electrons in this case is water molecules which are decomposed by water-oxidizing complex (WOC) of the PS II. Oxygen as a “waste” product of photosynthetic water cleavage led to the present-day aerobic atmosphere. From the very first moment the interaction with oxygen generated a new condition for the existing organisms starting an evolutionary adaptation process to this new oxidizing environment. Reactive oxygen species (ROS) became a powerful selector and generated a new hierarchy of life forms from the broad range of genetic mutations represented in the biosphere. During the electron transfer from water to NADP, protons are transferred from the stroma side (the positive (p) side) to the lumen side (the negative (n) side), and when this proton gradient is dissipated through the ATP-synthase, ATP is produced.

The next stage includes biochemical processes of fixation and reduction of CO_2 in photosynthetic carbon metabolism with using NADPH, and ATP. To date, the known metabolic pathways of carbon in photosynthesis can be classified into the 3-hydroxypropionat bicycle; the reductive citrate cycle, i.e., the Arnon-Buchanan cycle; C_3 or the reductive pentose phosphate cycle, i.e., the Benson-Bassham-Calvin cycle; C_4 or cooperative photosynthesis; Crassulacean acid metabolism (CAM); C_3/C_4 photosynthesis; and C_4 -CAM photosynthesis. Some of them, for example the 3-hydroxypropionat bicycle and the Arnon-Buchanan cycle, are specific to anoxygenic phototrophs, others, such as C_4 , CAM, and so on, have been in the

evolution of higher plants. The most important way of carbon in photosynthesis – the Benson-Bassham-Calvin cycle – is widespread in phototrophic organisms of different taxa. Eventually, fixation and reduction of CO_2 during photosynthesis leads to the formation of sugars and other organic compounds.

The present book has 8 chapters written mainly by the researchers of the Institute of Basic Biological Problems of the Russian Academy of Sciences (formerly the Institute of Photosynthesis). The each chapter describes photosynthesis at different levels of organization: molecular, cellular, and organismic. Among discussed problems in this book are: the structural and functional organization of the pigment-protein complexes; the evolutionary origin of the water-oxidizing complex of PS II; the hydrogen photoproduction coupled with photosynthesis; the structure and regulation of chloroplast ATP synthase; the formation, decay and signaling of reactive oxygen species in oxygen-evolving photosynthetic organisms during exposure to oxidative stress; the strategy of adaptation of photosynthetic carbon metabolism; the adaptive changes of photosynthesis under enhanced CO_2 concentration, and the photosynthetic machinery response to low temperature stress.

The material presented here reflects, mainly, the research interests and views of the authors. We do not claim to have produced all-inclusive views of the entire field. The book is intended for a broad range of researchers and students, and all who are interested in learning the most important global process on our planet – the process of photosynthesis.

We should like to believe that this book will stimulate future researchers of photosynthesis, leading to progress in our understanding of the mechanisms of photosynthesis and in its practical use in biotechnology and human life.

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