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INTELLIGENT DESIGN AND THE DYNAMICS OF ENERGY FLOW AND ECOLOGICAL INTERDEPENDENCE

by

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Introduction

A complex mega-machine (the largest on earth) designed to resolve whether a so-called 'God particle' exists (that would account for the nature of mass); explain the 'dark matter' and 'dark energy' (that account for 96% of the cosmos) and whether other dimensions exist in parallel to our own, took 20 years to construct and cost the European Organization for Nuclear Research (CERN) a whopping $5.46 billion. The massive Large Hadron Collider (LHC) is located 100 m underground in a 27 km circular tunnel on the Swiss-French border. In the LHC, parallel beams of protons (clockwise and anticlockwise) will be accelerated to nearly the speed of light up to 11 000 laps per second before colliding, generating massive amount of energy up to 14 teraelectronvolts. Even after 14 years of hard work on the collider and a long and cautious test commissioning process which climaxed at 0730 GMT, September 10, 2008 with the injection of the first proton beam into the LHC, allaying the fears of any 'black hole' (whose supergravity would swallow the Earth), Lyn Evans, the LHC leader admitted 'it's a machine of enormous complexity and things can go wrong at any time' [1]. And things did go wrong seven days later (September 19) after the successful test - A 'massive' magnet quench caused temperature to soar by about 100 degrees in about 100 of LHC's super-cooled magnets and a leakage of about a tonne of liquid helium in the tunnel [2].

Design and the designer are often easy to see and acknowledged in man-made inventions than in natural systems. Comparatively, science sees but often shudders to acknowledge the designer in nature. Just as man-made machines, we see complexity and interdependence that are highly coordinated and discreetly managed for effective system performance. In living systems, the complexity, interdependence and coordination are even more complicated, discreet and well integrated such that the failure or removal of any part causes the system to cease out-rightly. Michael Behe, a biochemist, in his book 'Darwin's Black Box' defines 'Irreducible complexity' (IC) as:

> *'A single system composed of several well-matched, interacting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning'* [3].

He found this to be true of several cell molecular machines and organelles e.g. the flagellum with parallel example in the mousetrap.

This paper examines the interdependence and integration of biotic and abiotic components of our environment in the flow, conversion and utilization of energy in the ecosystem for its effective performance and sustenance. It particularly focuses on the leaf factory primary production machinery consisting of well-integrated and organized complex structures (chloroplasts thylakoid membrane systems) and highly regulated photochemical reactions and electron transport systems. It asks whether these interdependence and complexity were a result of chance or Intelligent Design (ID)? Design connotes independently identifiable specified pattern in highly improbable complex events [4, 5]. Could the system function at all without any one of these components? Or Irreducibly Complex (IC) wherein the removal of any one part of these functionally interdependent parts causes it to cease functioning effectively [5].

Energy Source in the Ecosystem

The primary source of energy for nearly all life is the Sun-*light*. It flows through the ecosystem *unidirectional* and *non-cyclical*. Sunlight is non-renewable, non-replenishable special gift from the Creator. Thus, the first major intervention of God in the beginning was the introduction of light – 'Let there be light'. The light illuminated the darkness upon the deep of the shapeless and empty earth (Genesis 1: 1-4). In between the creation week, God qualified and reinforced the light on the fourth day. 'Let there be lights in the firmament of the heavens…' (Genesis 1: 14-19).

Energy Flow and conversion in the Ecosystem - Plants

Light energy is converted into chemical free energy in the ecosphere through photosynthesis by green plants, algae and some bacteria. Specifically, photosynthesis has been applied to organisms that use chlorophyll (or bacteriochlorophyll) to convert light energy into chemical free energy consisting of Bacteria (photosynthetic bacteria) and Eucaryotes (algae and higher plants). Halobacteria (Archaea), though convert light energy into chemical free energy, do not undergo oxidation-reduction reactions and cannot use CO_2 source hence usually not considered photosynthetic [6]. On the third day, God created the plants. Was the light existing from the first day sufficient for the plants to photosynthesize before '*sun*-light' was made on the fourth day OR the fourth-day sunlight was in direct response to the photosynthetic needs of the plants? Suffice it to say that 'God is light'.

Photosynthetic pigments

Chlorophyll has a magnesium atom chelated in the center of a porphyrin ring with a long tail of alcohol phytol. All eucaryotic phototrophs have chlorophyll a (chl a) and smaller amounts of chl b (plants and green algae) or chl c (golden brown and brown algae). . Plants appear green because of chlorophyll, which is so ubiquitous that regions of the earth appear green from space. Phototrophic bacteria have similar bacteriochlorophylls. Secondary pigments, carotenoids (carotenes and xanthophylls) complement chlorophylls. Chlorophyll absorbs blue and red light (c. 410 – 660 nm) while carotene is active in the blue-violet range (c. 449 – 478 nm). The carotenoids are essentially similar to retinal, the major pigment that absorbs light in the eye – *An Intelligent designer of both plant and animal structures would be capable of such parallel duplication and modification.*

Photosynthesis may result in the production of oxygen (O_2) (Oxygenic e.g. plants, algae and certain photosynthetic bacteria) or not (Anoxygenic e.g. purple, green sulphur, green gliding and gram positive bacteria). In oxygenic photosynthesis, electrons are removed from water leading to release of O_2. The structure and function of photosystem II and I where the reaction takes place are similar in plants, algae and certain bacteria. *Again, we see the creative power of an ID replicating parallel structures in lower and higher organisms.*

The Chloroplast – Structure, organization and origin

The leaf is both a complex organ of structure and function. The leaf provides CO_2, water, nitrogen, organic molecules and minerals for the photosynthetic process. In plants and algae, photosynthesis occurs in small organelles known as chloroplasts that are located inside the mesophyll cells of the leaf. The chloroplasts are generally disc-shaped, about

5-10 μm in diameter and 25 – 50 or more in each upper palisade mesophyll cell where most photosynthesis takes place.

Chloroplasts are mobile in the cytosol, change their shape and orientation in response to changing light intensities. They are bound by a double membrane and contain an extensive membrane system called the thylakoid membrane. The membrane is a two-dimensional surface that creates an internal closed space, the lumen and an outer space, the stroma forming a vesicle. The thylakoid is folded into stacks of disc-shaped vesicles called the grana interconnected by network of non-stacked membranes that protrude from the edges of the stacks. The photosynthetic membrane is composed mainly of glycerol lipids and protein. The glycerol lipids are bilayer with a hydrophilic polar head group toward the water phase and two fatty acid side chains that forms a hydrophobic core. The light dependent reactions of photosynthesis which consist of electron and proton transfers occur in the thylakoid-lumen while the biosynthesis of carbohydrates from Carbon dioxide (CO_2) in the dark reaction takes place in the stroma. The inner envelope membrane acts as a barrier that regulate the flow of organic and charged molecules in and out the chloroplast but allows water (H_2O), CO_2, Oxygen (O_2) and small neutral molecules freely (Fig 1). *This indeed is an enormously complex system that is highly specified.*

Hypothetically, for over 100 years, chloroplast was thought to evolve by endosymbiotic gene transfer from an encounter between an eukaryotic host cell and a probable ancestor of cyanobacteria [7, 8]. Information was built over the years from electron microscopic and biochemical studies for non-Mendelian, cytoplasmic inheritance basis of plastid-related characters. Lately, molecular phylogenetic studies infer homology in structure and function of plastids and cyanobacteria [9] particularly the photosystem II water oxidation reaction. Having long realized that many of the proteins needed for plastid functions, including photosynthesis are encoded in the nuclear genome, it postulated wholesale uptake of cyanobacteria, including their genomes, followed by gene transfer into the nucleus over long period evolution [10]. However, such gradual evolution did not result in radical change in the structure and functions of the Proterozoic cyanobacteria and algae,

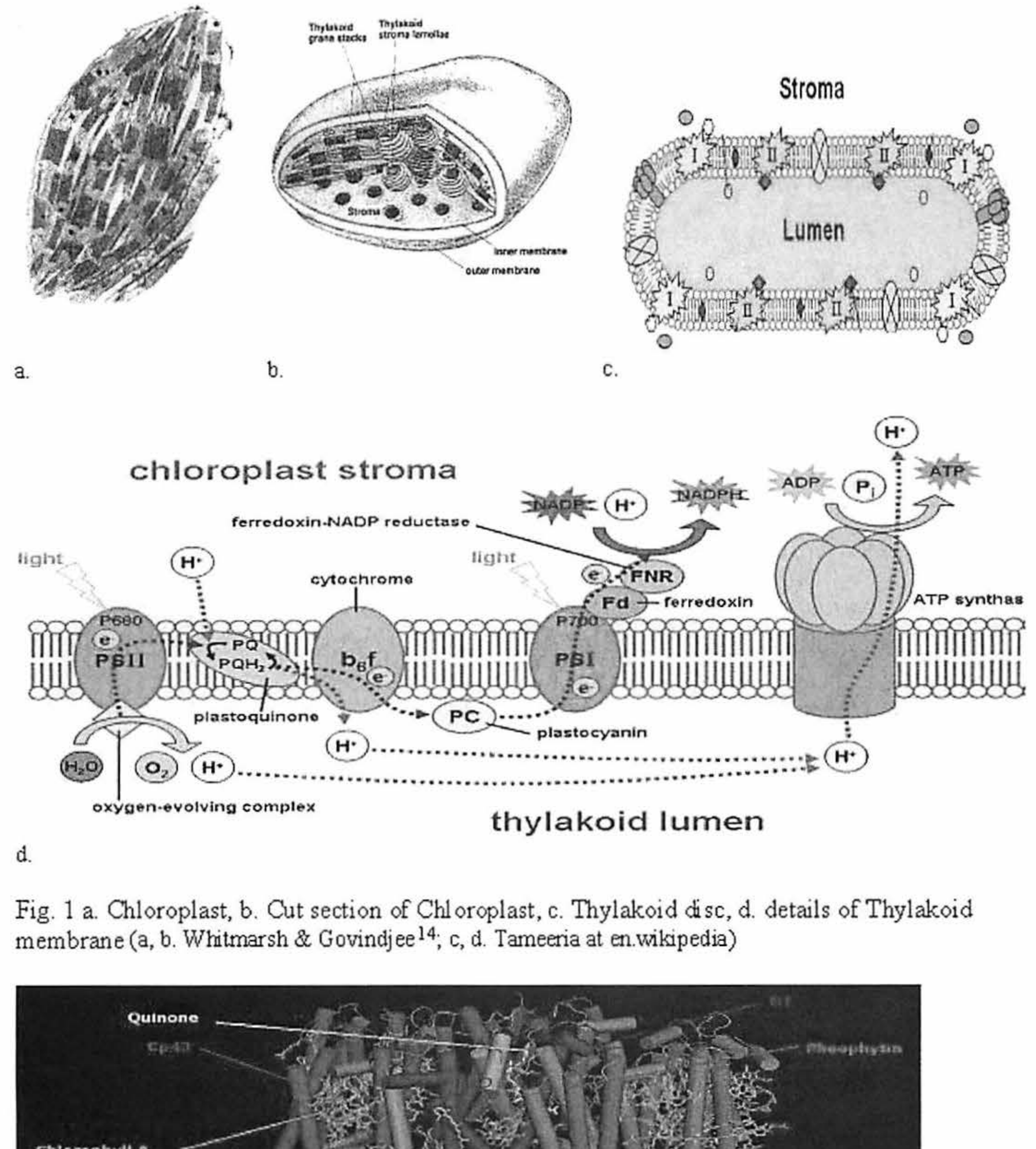


Fig. 1 a. Chloroplast, b. Cut section of Chloroplast, c. Thylakoid disc, d. details of Thylakoid membrane (a, b. Whitmarsh & Govindjee[14]; c, d. Tameeria at en.wikipedia)

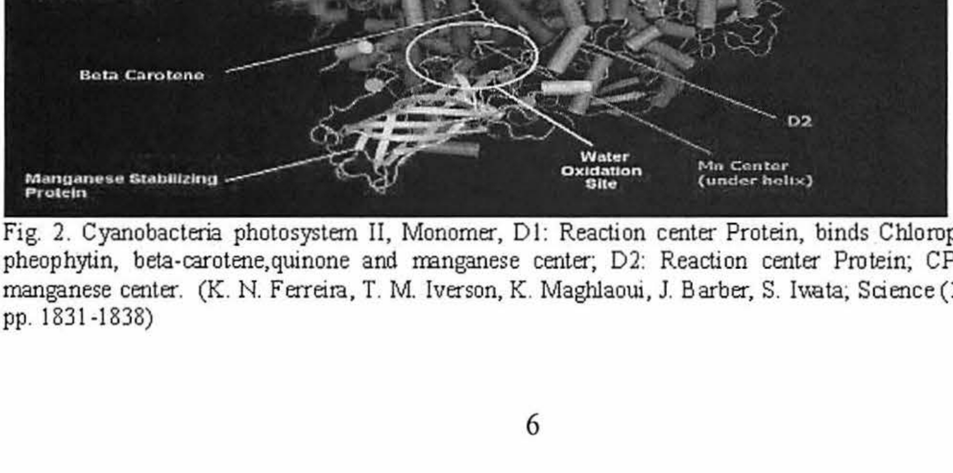


Fig. 2. Cyanobacteria photosystem II, Monomer, D1: Reaction center Protein, binds Chlorophyl P680, pheophytin, beta-carotene,quinone and manganese center; D2: Reaction center Protein; CP43: Binds manganese center. (K. N. Ferreira, T. M. Iverson, K. Maghlaoui, J. Barber, S. Iwata; Science (2004) 303; pp. 1831-1838)

and Cretaceous (Mesozoic) flowering plants over 2000 million years. At least one researcher asked pertinent questions 'How are genes transferred from organelles to the nucleus (or to other organelles)? For what reasons might these transfers occur? and concluded that 'At the momment, an actual mechanism is not known' [11]. Nevertheless, a group of researchers argued almost convincingly but purely speculative "The process of transfer of genes to the nucleus *would have* involved duplication of each plastid gene, and a nuclear copy of the gene *becoming able* to produce a functional product in the cytosol or, *with appropriate targeting sequences, in other compartments"*.

Arber Werner, a microbiologist, and Nobel Laureate in physiology and medicine - for the discovery of restriction enzymes and their application to molecular genetics, captured the far-fetch implications of complexity of molecular machines and their origin when he stated:

> *'Although a biologist, I must confess I do not understand how life came about.... I consider that life only starts at the level of a functional cell. The most primitive cells may require at least several hundred different specific biological macro-molecules. How such already quite complex structures may have come together, remains a mystery to me. The possibility of the existence of a Creator, of God, represents to me a satisfactory solution to this problem'* [12]

It is doubtful if the different parts of the chloroplast-thylakoid membrane system: photosystems II and I, water oxidation complex, cytochrome complex, ATP synthase: were assembled randomly and gradually over time to make an evolutionary sense and yet gain a competitive advantage. The immense complexity and high specificity from the onset in the cyanobacteria (Fig. 2) approaches those of the algae and plants and are highly improbable to be left to chance or natural blind forces. The challenge of having all of the evolutionary complexity from the outset requires an actual mechanism beyond the hypothetical endosymbiosis. Nonetheless, the proponents of this theory, 100 years over, bid for time in the hope that the actual mechanism will be found someday. Such position requires a 'faith commitment' far beyond that needed to envision ID. For functional advantage, it is rational to have all the parts present and assembled in a well-integrated manner as it is found. *Only an ID is capable of such specified complexity and assemblage using similar template plastid structure in the cyanobacteria, algae and plants, which defy gradual naturalistic process and fanciful contrived mechanism.*

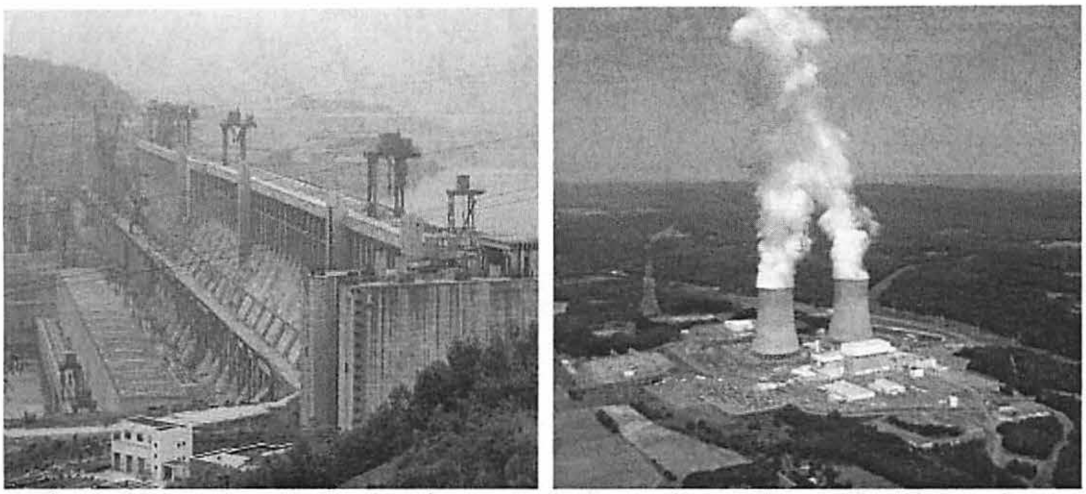
Dr. Werner von Braun (1912-1977), a leading scientist in US Space program until his death, aptly stated it:

> '*One cannot be exposed to the law and order of the universe without concluding that there must be design and purpose behind it all. In the world around us, we can behold the obvious manifestations of an ordered, structured plan or design ... The better we understand the intricacies of the universe and all it harbors, the more reason we have found to marvel at the inherent design upon which it is based . . . To be forced to believe only one conclusion - that everything happened by chance - would violate the very objectivity of science itself... What random process could produce the brains of a man or the system of the human eye? ... They (evolutionists) challenge science to prove the existence of God. But must we really light a candle to see the sun? ... They say they cannot visualize a Designer. Well, can a physicist visualize an electron? ... What strange rationale makes some physicists accept the inconceivable electron as real while refusing to accept the reality of a Designer on the ground that they cannot conceive Him? ... It is in scientific honesty that I endorse the presentation of alternative theories for the origin of the universe, life and man in the science classroom. It would be an error to overlook the possibility that the universe was planned rather than happening by chance*'[13].

If it so easy for us to recognize design and the designer in complex and highly regulated parallel man-made power generating machines (Fig. 3), why is it difficult for us to see the design-signature and inference behind molecular machines? (Figs. 1 & 2).

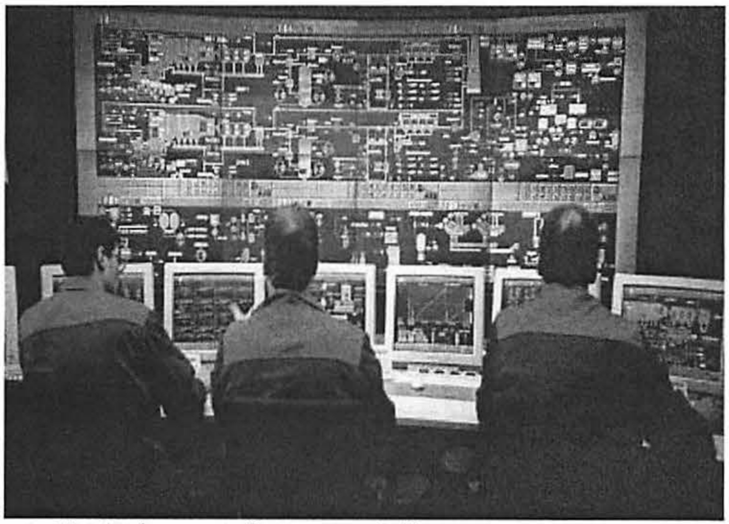
Light absorption

A photon of light is absorbed by 200-300 pigment molecules bound to the light-harvesting protein complexes (Photosystem II) surrounding a reaction center that serves



a. Three Gorges Dam Hydroelectric Power Station, China

b. Susquehanna Steam Electric-Nuclear Power Station, Pennsylvania, USA



c. Control room of a power station

Fig. 3. Fig. 4. Electric Power generation

(a. Christoph Filnkößl, en.wikipedia; b. US Fed. Govt., en.wikipedia; c. *VGB Power Tech GmbH* Germany, commons.wikimedia) as an antenna. The protein determines the position and orientation of the antenna pigments (Fig. 2). The absorption translates the energy from ground zero to excited state in 10 - 15 fs. Guided by the protein complex and the interaction of the dipole moment of the emission-absorption spectra of the donor-acceptor antenna molecules and their distance (1/R6), the energy is transferred by resonance to the reaction center. In optimum conditions over 90 % of the absorbed quanta reached the reaction center in a few 100 picoseconds [14].

The electron transport system:

The light energy so absorbed is used to drive the oxidation of water and the reduction of plastoquinone in Photosystem II. More than fifteen polypeptides and at least nine different redox components (chlorophyll, pheophytin, plastoquinone, tyrosine, Mn, Fe, cytochrome b559, carotenoid and histidine) had been found to undergo light-induced electron transfer [15]. However, only five of these have been found to transfer electrons from H_2O to the plastoquinone pool (the water oxidizing manganese cluster (Mn)4, the amino acid tyrosine, the reaction center chlorophyll (P680), pheophytin, and the plastoquinone molecules - QA and QB). The last four were bound to two key polypeptides that form the heterodimeric reaction center core of photosystem II (D1 and D2). D1 and D2 polypeptides have also been shown to provide ligands for the (Mn)4 cluster (Fig. 2).

Photosystem II reaction is initiated by charge separation between P680 and pheophytin (P680+/Pheo-) (3 fs). The electron is subsequently transferred to plastoquinone – QA (200 ps, fast enough so that the charges do not recombine) and QB. Whereas, Plastoquinone is permanently bound to Photosystem II at QA and a one-electron acceptor, it is loosely bound at QB and accepts two electrons. Only Photosystem II protein complex is capable of oxidizing water, resulting in the release of practically all of our atmosphere's oxygen. The molecular events leading to water oxidation are poorly understood since water naturally, is a poor electron donor. *To date, this water-splitting catalytic centre cannot be reproduced by any man-made catalyst.* This is yet another evidence of ID. Furthermore, Certain redox components (eg. Cytochrome b559, a heme protein) of PS II reaction centers do not have any known function. However, their removal will lead to unstable PS II reaction [16]. A case of IC. Many plants and algae also possess good number of PS II reaction centers that do not participate in the electron transport system. The net reaction results in the release of one O_2 molecule, the deposition of four protons into the inner water phase, and the transfer of four electrons to the QB-site producing two reduced plastoquinone molecules.

PS I complex has a heterodimer of proteins acting as ligands for most electro transport system (ETS). It directs the oxidation of plastocyanin, (soluble Cu-protein) and reduction of ferredoxin, (FeS protein). The reaction center has an antenna system of about 200 chlorophyll molecules (mainly chl a). Unlike PS II, many of the antenna chlorophyll molecules are bound to the reaction center proteins. FeS centers serve as electron carriers and the electron transfer is not coupled to proton translocation. Charge separation occurs between a primary donor, P700, a chlorophyll dimer, and a chlorophyll monomer (Ao).

Electron transport from water to NADP+ requires three membrane bound protein complexes operating in series - photosystem II, the cytochrome bf complex and photosystem I (Fig. 1 d). Small mobile electron carrier molecules (plastoquinone and plastocyanin in plants) transfer electrons (or hydrogen molecules) from PS II reaction center to the cytochrome bf complex and carries protons across the photosynthetic membrane (Kallas, 1994). Plastoquinone is hydrophobic and its movement is restricted to the hydrophobic core of the photosynthetic membrane. The reduced plastoquinone molecule (PQH2) debinds from photosystem II and diffuses randomly in the photosynthetic membrane until it encounters a specific binding site on the cytochrome bf complex. The cytochrome bf protein complex contains four electron carriers, three cytochromes and an FeS center. *In a complex reaction sequence not fully understood*, the cytochrome bf complex removes the electrons from PQH2 and facilitates the release of the protons into the inner aqueous space. The electrons are eventually transferred to the photosystem I reaction center by small water soluble Cu-protein, plastocyanin (PC), in the inner water space. Electron transfer from photosystem I to NADP+ requires ferredoxin, a small FeS protein, and ferredoxin-NADP oxidoreductase, a peripheral flavoprotein. Ferredoxin and NADP+ reductase are water-soluble and are found in the outer aqueous phase of the photosynthetic membrane [14].

Proton electrochemical potential

Electrons pathway is largely determined by the energetics of the reaction and the distance between the carriers. Following primary charge separation, electron transport is energetically downhill (from a lower (more negative) to a higher (more positive) redox potential) – the Z scheme. It is the downhill flow of electrons that provides free energy for the creation of a proton chemical gradient. Electron transport creates the proton electrochemical potential of the photosynthetic membrane by two types of reactions. (1) The release of protons during the oxidation of water by photosystem II and the translocation of protons from the outer aqueous phase to the inner aqueous phase by the coupled reactions of photosystem II and the cytochrome bf complex in reducing and oxidizing plastoquinone on opposite sides of the membrane. This creates a concentration difference of protons across the membranes. (2) Primary charge separation at the reaction center drives an electron across the photosynthetic membrane, which creates an electric potential across the membrane. Together, these two forms of energy make up the proton electrochemical potential across the photosynthetic membrane, which is related to the pH difference across the membrane and the electrical potential difference across the membrane [14].

ATP synthase

The reaction is driven by proton transfer through the ATP synthase protein – *an exceptional molecular machine*. ATP Synthase is made up of two main parts: F_1 and F_0. The F_0 subunit occurs in the photosynthetic membrane and forms a proton channel through the membrane. The F_1 subunit is attached to the top of the F_0 located on the outside of the membrane in the aqueous space (Fig. 4). F_0 has three types of subunits: proteins 'a', 'b', and 'c'. Of these, F_0 has one 'a', two 'b's, and nine-twelve 'c's [17]. F_1 has five subunits: three alphas, three betas, one gamma, one delta, and one epsilon. The beta subunit is where synthesis of ATP actually occurs. The gamma, delta, and epsilon subunits are not symmetrical. F_1 contains the catalytic center for ATP synthesis. The F_0

subunit catalyses the synthesis of ATP from ADP and inorganic phosphate Pi driven by a flux of protons across the membrane down the proton gradient generated by electron transfer. The flux goes from the protochemically positive side (high proton electrochemical potential) to the protochemically negative side. The reaction catalyzed by ATP synthase is fully reversible, so ATP hydrolysis generates a proton gradient by a reversal of this flux [18].

$ADP + Pi + nH^+_P \Leftrightarrow ATP + nH^+_N$.

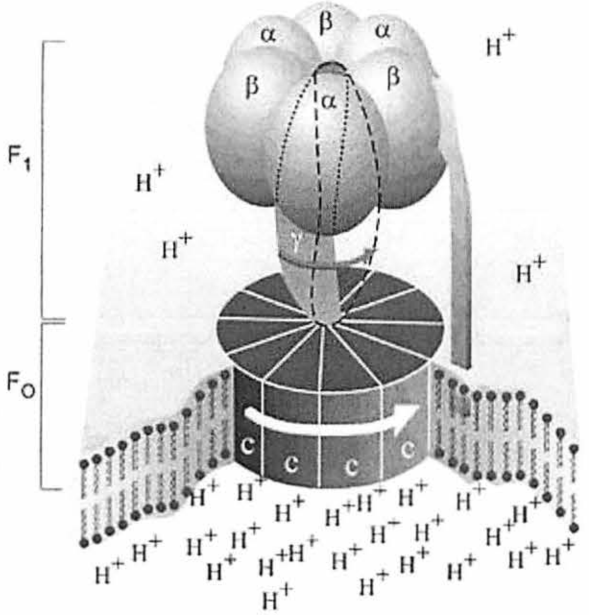


Fig. 4. Light driven ATP Synthesis
(http://nobelprize.org/nobel_prizes/chemistry/laureates/1997/press.html)

Synthesis of carbohydrate

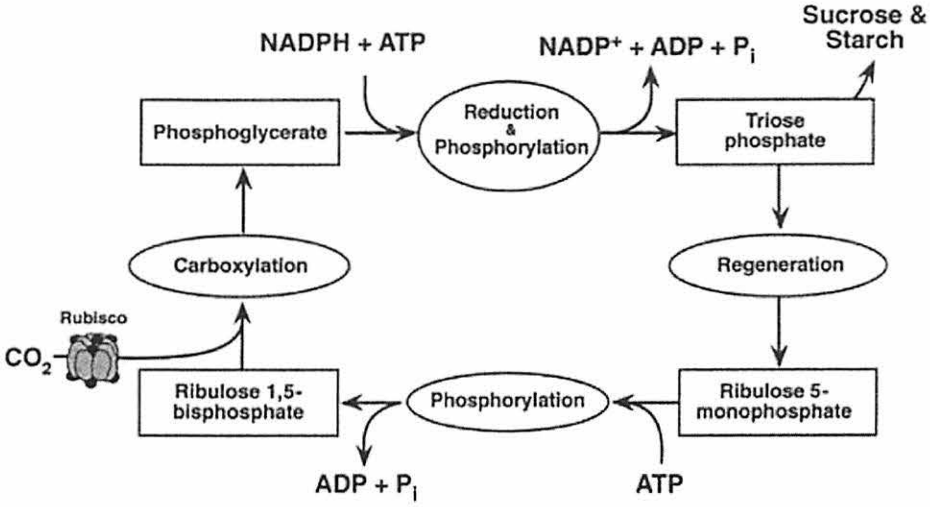
A complex set of physical and chemical reactions must occur in a coordinated manner for the synthesis of carbohydrates. *To produce a sugar molecule such as sucrose, plants require nearly 30 distinct proteins that work within a complicated membrane structure.*

Calvin (C3) cycle: The first step is the addition of CO_2 to a five-carbon compound (ribulose 1,5-bisphosphate). The six-carbon compound is split, giving two molecules of a 3-C compound (3-phosphoglycerate). This key reaction is catalyzed by Rubisco, a large water-soluble protein complex. The carboxylation reaction is energetically downhill. The main energy input in the Calvin cycle is the phosphorylation by ATP and subsequent reduction by NADPH of the initial 3-C compound forming a 3-C sugar, triosephosphate. Some of the triosephosphate is exported from the chloroplast and provides the building block for synthesizing more complex molecules. In a process known as regeneration, the Calvin cycle uses most of its triosephosphate molecules (5/6) to synthesize the energy rich ribulose 1,5-bisphosphate needed for the initial carboxylation reaction and a smaller fraction (1/6) to produce sugar. This reaction requires the input of energy in the form of one ATP. *Overall, 13 enzymes are required to catalyze the reactions in the Calvin cycle.* The energy conversion efficiency of the Calvin cycle is approximately 90%. The reactions do not involve energy transduction, but rather the rearrangement of chemical energy. Each molecule of CO_2 reduced to a sugar $[CH_2O]n$ requires 2 molecules of NADPH and 3 molecules of ATP (Fig. 5a).

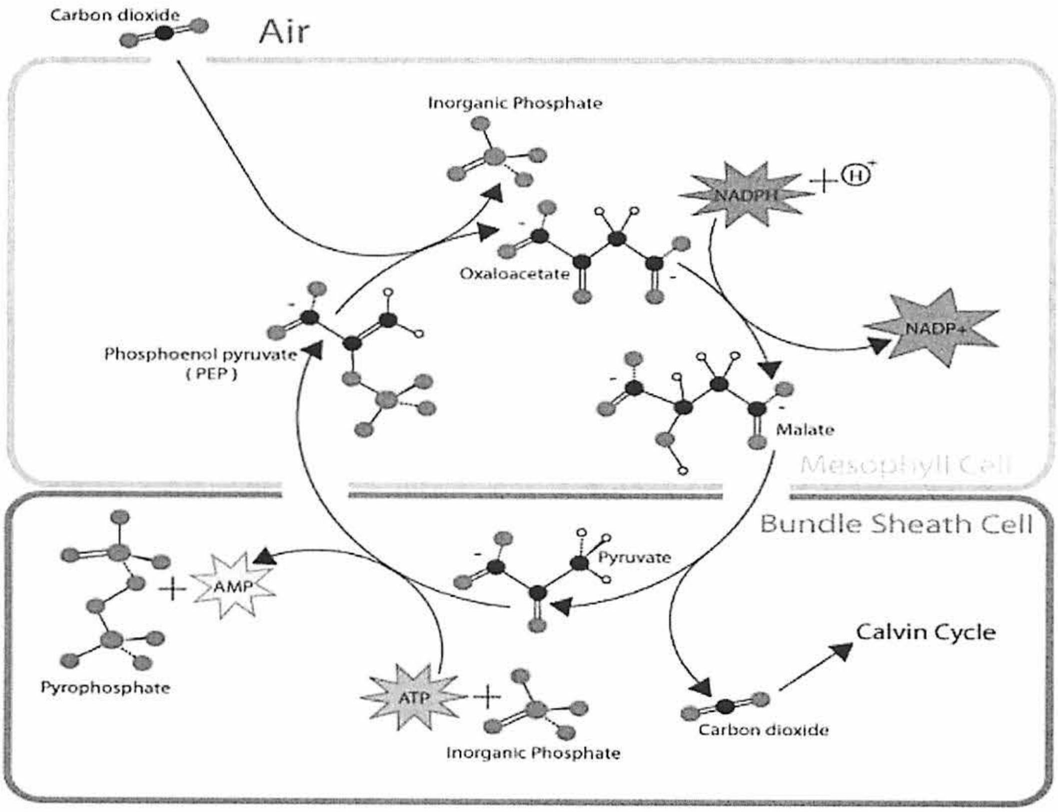
Hatch and Slack cycle – C4 and Crassulaceae Acid Metabolism (CAM): Rubisco is a bifunctional enzyme that, in addition to binding CO_2 to ribulose bisphosphate, can also bind O_2. This oxygenation reaction produces the 3-phosphoglycerate that is used in the Calvin cycle and a two-carbon compound (2-phosphoglycolate) that appears to serve no useful purpose for the plant. In response, a complicated set of reactions (termed photorespiration) are initiated that serve to recover reduced carbon and to remove phosphoglycolate. Some plants have evolved specialized structures and biochemical pathways that concentrate CO_2 near Rubisco. These pathways (C4 and CAM) decrease the fraction of oxygenation reaction [14] (Fig. 5b).

Energy Transfer in the Ecosystem

Herbivory: The primary consumer of plants' chemical free energy is the herbivores (plant eaters). These range from small insects on the grass field and planktons in marine to large animals (elephants, Cows). Between 20 and 25% of the energy fixed in photosynthesis (The Gross Primary Productivity, GPP) is used up by the plant for its own metabolism



a. Calvin (C_3) cycle (Whitmarsh & Govindjee [11])



b. Hatch and Slack cycle – C4 & Crassulaceae Acid Metabolism (commons.wikimedia)

Fig. 5. Synthesis of carbohydrate

chiefly respiration and photorespiration. The net gain (Net Primary Productivity, NPP) is stored by plant, available for the next trophic level. Not all the NPP is converted by the herbivores due indigestible cellulose and wood material lost as egestion. The energy converted is about 10% of the NPP. Energy is again lost in the form of heat from respiration and excretion of organic waste of metabolism, leaving the remaining energy, Secondary Production (SP), for growth, repairs and reproduction and to the next trophic level. Back in Eden God gave '*...every herb that yields seed which is on the face of all the earth, and every tree whose fruit yields seed...*' (Gen. 1: 29 – 30) as food to all His created creatures including human. This is the original Eden design and type. It was an entirely different order of interrelationships among the organisms and their environment. That of complete harmony foreseeable in restored Eden:

> *'The wolf also shall dwell with the lamb, and the leopard shall lie down with the kid; and the calf and the young lion and the fatling together; and a little child shall lead them. And the cow and the bear shall feed; their young ones shall lie down together: and the lion shall eat straw like the ox." Isaiah 11:6,7. .... and they shall plant vineyards, and eat the fruit of them. They shall not build, and another inhabit; they shall not plant, and another eat: for as the days of a tree are the days of my people, and mine elect shall long enjoy the work of their hands. They shall not labour in vain, nor bring forth for trouble; for they are the seed of the blessed of the LORD, and their offspring with them. ..... They shall not hurt nor destroy in all my holy mountain, saith the LORD' Isaiah 65:21-25*

Carnivory: The secondary consumers are animal-animal eaters, carnivores (Fig. 6). They like the herbivores are unable to convert all the energy stored by the herbivores (SP) and hence they only achieve about 20% energy conversion efficiency. Usually, they hunt and kill their prey as food. This antitype Eden behavior usually engenders stiff competition and 'survival of the fittest' both for the predator and prey in the ecosystem. It is a consequence of sin and the fall of human Gen. 3: 17 – 19a. This represents a degenerate ecosystem far from its original plan. As humans, we should foster and encourage beneficial relationships (symbiosis and mutualism) in our care and keep of the environment. This includes nature conservation.

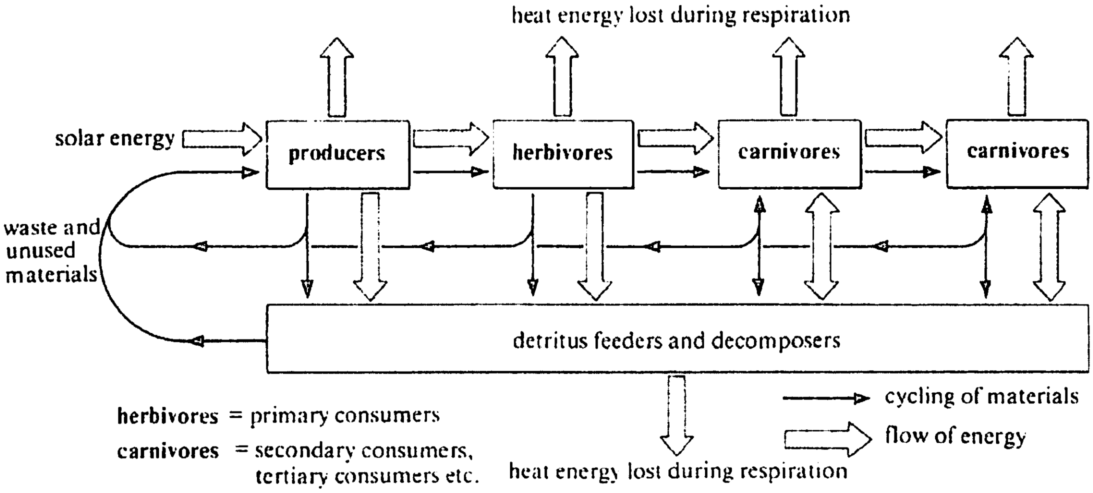


Fig. 6. Energy flow and nutrient cycling through a food chain (Taylor DJ, Green NPO & Stout GW. 1997. Biological Science. 3rd ed. Cambridge)

Decomposers and detritivores: Whereas energy is lost as heat in respiration, loss in the form of excreta, egesta, dead organisms, fallen leaves, twigs, branches, bone fragments etc is not lost to the ecosystem but transferred to the decomposers (bacteria and fungi) and the detritivores (blowflies, earthworm, termites, rag worms etc) and converted into useful chemicals and nutrients. Detrital pathways though non-apparent are often more complex than the common visible grazing food chain receiving enormous amount of energy from it and serving as energy source for it (Fig. 6). Intensive agricultural systems can benefit largely from the immense potential of the detrital-energy production. Waste recycling and management practices should also be encouraged.

With the fall came the wages of sin, death (Gen. 2:17, Romans 6:23), which was not part of the original plan for Eden. '*Wherefore, as by one man sin entered into the world, and death by sin; and so death passed upon all men, for that all have sinned*' (Romans 5:12). It is probable that decomposers and detritivores were a consequence of the fall, before and after the flood. While death has become a reality of the present world, it was unknown to Adam in his unfallen state and will be alien to Eden-restored.

Energy budget and Global Photosynthesis

Loss of energy at the trophic levels and efficiencies of energy conversion among others impose a limit on the extent of food chain and carrying capacity of the ecosystem. Of the sun irradiated energy, which reaches the earth, about 40% is reflected by the earth's surface, 15% absorbed and converted to heat energy by ozone layer and water vapor in the atmosphere. Only about half of the remaining 45% is in the visible wavelength, Photosynthetic Active Range (PAR). In optimum conditions only about 10% of PAR is converted into GPP but under normal conditions only 2% PAR, about 0.2% of total incident radiation. NPP varies between 50 - 80% of GPP. As a global average, the energy fixed by earth's green plants amounts to only 0.1% of the incident visible radiant energy. The minimum quantum requirement for photosynthesis is 8 quanta of O_2 evolved, 4 each for photosystems I and II. The theoretical maximum of energy conversion efficiency for 8 quanta (c. 1,400 kJ) for each molecule of CO_2 reduced (480 kJ/mol) is 34%.

Table: Net ecosystem (NEP) and Net primary production (NPP) in three major regions [20]

Region	Vegetated area (M2/10^{12})[a]	NEP	NPP	NEP/NBP[b] (%)
North America	20	0.8	7	12
Eurasia	39	1.7	11	15
Tropics	47	0.4	36	1

[a]Estimates of vegetated area from satellite measurements, uptake from atmospheric data, productivity from model estimates. [b]1% NEP/NBP for tropics probably indicates high emission than regional actual ecological efficiency [20]

Terrestrial systems, which covers about 30% of the earth, fix half of the total incident radiation. Global terrestrial GPP estimated from measurements of O_2 uptake by plants is about 120 GtC (gigatons of carbon) per year. Global terrestrial NPP ranges from 52 – 60 GtC yr $^{-1}$. Energy loss by way of respiration of consumed plant material by animal, fungi and bacteria leaves the Net Ecosystem Production (NEP), which is the amount of Carbon gained by the ecosystem in the absence of fire or any other means of removal of Carbon. In essence, nearly all the Carbon fixed by NPP is returned back to the atmosphere by respiration or fire. NEP could also loose Carbon by fire, erosion and dissolved organic carbon (DOC) to rivers leaving Net Biome Production (NBP) which represents the net gain of Carbon by land per year. NBP is zero for stable ecosystems though ecosystems are seldom in a steady state (Table) [19].

Conclusion

None of the components of the chloroplast, even when they do not serve a particular known function (Cyt. b559, extra PS II reaction centers) can be removed without altering the performance of the system. The energy necessary to drive our ecosystem is impossible without its rich source, the Sun (an ID gift from the Creator), its conversion by the plants and chemical recycling by microorganisms. IC in the structure and function of living systems such as the chloroplast is not directed by blind forces of evolution but ID by a designer just as apparent and undeniable in modern technology and construction e.g. computer systems, power stations. Furthermore, the synergy of biotic and abiotic factors of ecosystem for energy supply, transformation and sustenance are not due to chance but purposed by a Creator who governs by a set of laws. The laws can be studied and understood following his commandments just like any other manual designed for operating appliances. Eden-type ecosystem reminds us of our responsible role and positive interaction in the care and keep of the environment. The negative interaction that characterizes our present degenerate ecosystem as a result of sin is an antitype. We look forward with earnest expectation to the restoration of Eden at His second and final coming.

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