

Nucleic Acid Metabolism and Its Flow in Ecosystem

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Abstract - The nucleic acids are the hereditary determinants of living organisms. They are the macromolecules present in most Living cells either in the Free State or bound to proteins as nucleoproteins. The nucleic acid molecule is a linear polymer in which the monomers are linked together by means of phosphodiester "bridges" or bonds. In food chain of ecosystem the nucleic acid and its reactions also flow with energy and nutrients from producers to consumers.

Keywords: Nucleic acid, Flowing of nutrients, Food Chain, Replication, Transcription.

I. INTRODUCTION

The nucleic acids are the molecular repositories for genetic information and are jointly referred to as the "molecules of heredity". The structure of every protein, and ultimately of every cell constituent, is a product of information programmed into the nucleotide sequence of a cell's nucleic acid. There are two classes of nucleic acids, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), DNA is the hereditary molecule in all cellular life-forms, as well as in many viruses. DNA has two functions:

- i) To direct its own replication during cell Division.
- ii) To direct the transcription of complementary molecules of RNA.

RNA, in contrast, has following biological functions

- i) The RNA transcripts of DNA sequences that specify polypeptides, messenger RNAs (mRNAs) direct the ribosomal synthesis of these polypeptides in a process known as translation,
- ii) The RNAs of ribosome's, which are about two thirds RNA and one third protein, have functional as well as structural roles.
- iii) During protein synthesis, amino acids are delivered to the ribosome by molecules of transfer. RNA (tRNA).
- iv) Certain RNAs are associated with specific proteins to form ribo-nucleoproteins that participate in the post transcriptional processing of other RNAs.
- v) A variety of short RNAs participate in the Control of eukaryotic gene expression and in a protection against viruses, a phenomenon known as RNA interference (RNAi).

- vi) In many viruses, RNA, not DNA is the carries of hereditary Information,

Metabolism represents that sum of the Chemical changes that convert nutrients, the raw material necessary to nourish living organisms, into energy and the chemically complex finished products of cells. Metabolism consists of literally hundreds of enzymatic reactions organized into discrete pathways. These pathways proceed in a stepwise fashion, transforming substrates into end products through many specific chemical intermediates. Metabolism is sometimes referred to as intermediary metabolism to reflect this aspect of the process.

Although most cells have the same set of central metabolic pathways, different cells are characterized by the alternative pathways they might express. These pathways offer a wide diversity of metabolic possibilities, For instance, organisms are often classified according to the major metabolic pathways they exploit to obtain carbon or energy.

Classification based on carbon requirements defines two major groups; autotrophs and Heterotrophs. Autotrophs are organisms that can use just carbon dioxide as their sole source of carbon. Heterotrophs require an organic form of carbon, such as glucose, in order to synthesize other essential carbon compounds.

Classification based on energy sources, also gives two groups: phototrophs and chemotrophs. Phototrophs are photosynthetic organisms, which use light as a source of energy. Chemotrophs use organic compounds such as glucose or, in some instances, oxidizable inorganic substances such as Fe^{2+} , NO_2^- , NH_4^+ or elemental sulphur as sole sources of energy. Typically, the energy is extracted through oxidation - reduction reactions. Based on these characteristics, every organism falls into - one of four categories.

Prokaryotes show a greater metabolic diversity than all the four eukaryotic Kingdoms Protocista (Protozoa), Fungi, plants, Animals put together. Prokaryotes are variously chemo-heterotrophic, photo autotrophic, photo heterotrophic, or Chemoautotrophic. No protocista are chemoautotroph's fungi and animals are exclusively chemo heterotrophs; plants are characteristically photo autotrophs although some are heterotrophic in their mode of carbon acquisition.

According to Smith (1966), the following general characters represent the ecosystem:-

- i) The ecosystem is a major structural and functional unit of ecology.
- ii) The structure of an ecosystem is related to its species diversity, the more complex ecosystems have high species diversity.
- iii) The function of the ecosystem is related to energy flow and material cycling through and within the system.
- iv) The relative amount of energy needed to maintain an ecosystem depends on its structure. The more complex the structure, the lesser the energy it needs to maintain itself.
- v) Ecosystems mature by passing from less complex to more complex states. Early stages of such succession have an excess of potential energy and a relatively high energy flow per unit biomass. Later (mature) stages have less energy accumulation and it's through more diverse components.
- vi) Both the environment and the energy fixation in any given ecosystem are limited and cannot be exceeded without causing serious undesirable effects.
- vii) Alterations in the environments represent selective pressures upon the population to which it must adjust organisms which are unable to adjust to the changed environment must need vanish.

The ecosystem is an integrated unit or zone of variable size, comprising vegetation, fauna, microbes and the environment. Most ecosystems characteristically possess a well-defined soil, climate, flora and fauna and have their own potential for adaptation, change and tolerance. The functioning of any ecosystem involves a series of cycles, e.g. the water cycle and the cycles of various nutrients. These cycles are driven by energy flow, the energy being the solar energy continuation of life demands a constant from exchange and return of nutrients to and the different components of the ecosystems.

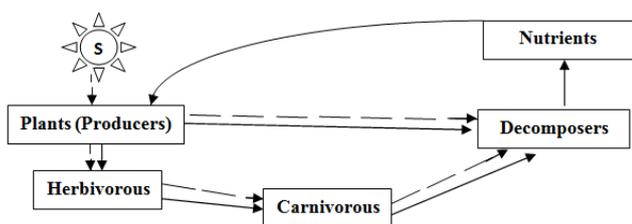


Figure 1: Flowing of Energy on Ecosystems

II. METABOLIC REACTIONS OF NUCLEIC ACIDS

1. DNA Replication

Transfer of genetic information to from generation to generation requires the faithful reproduction of the parental

DNA copies DNA reproduction produces two identical of the original DNA in a process termed DNA replication.

DNA is replicated by enzymes known as DNA-directed DNA polymerase or simply DNA polymerases. These enzymes utilize single - stranded DNA as template on which to catalyze the synthesis of the complementary strand from the appropriate deoxy nucleoside triphosphates. The incoming nucleotides are selected by their ability to form Watson - Crick base pairs with the template DNA so that the newly synthesized DNA strand forms a double helix with the template strand. Nearly all known DNA polymerases can only add a nucleotide donated by a nucleoside triphosphate to the 3'-OH group of a base paired polynucleotide so that DNA chains are extended only in the 5' 3' direction.

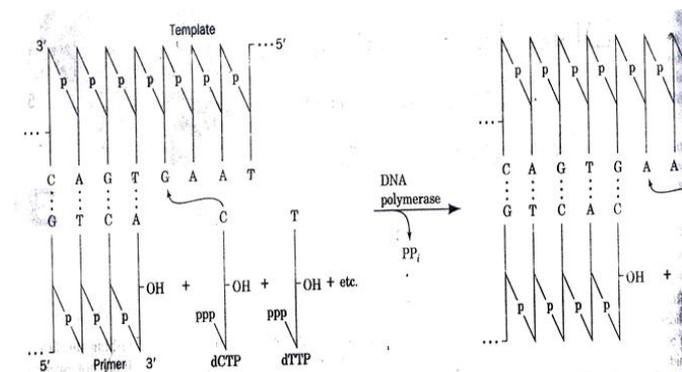


Figure 2: Action of DNA polymerase. DNA polymerases assemble incoming deoxynucleoside triphosphates on single-stranded DNA templates such that the growing strate elongated in its 5' 3' direction

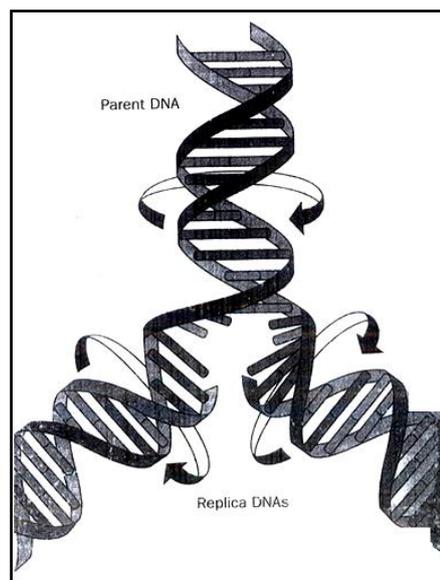


Figure 3: Replication of DNA

2. Replication of RNA

The similarity in general structure between RNA and DNA, when first noted, suggested a similarity in the

replication mechanism. For some times it was therefore through that each of these nucleic acids could replicate independently of each other. That is, just as a stand of DNA could attract free deoxyribonucleotides to form a complementary strained cellular RNA could do the same with free ribonucleotides. However, except for some RNA viruses which appear to replicate through a double-stranded RNA intermediate, considerable evidence indicates that all or most cellular RNA is of nuclear origin and derives from DNA templates.

If RNA arises directly from DNA, its purine and pyrimidine base composition should be similar to that of the process the replication produced it, since seems to occur through the pairing of complementary bases of course, some DNA sequences may produce more RNA than other sequences and such DNA may have a unique base composition on compared to the overall DNA base ratios.

RNA originating from DNA would be expected to have a purine and pyrimidine base sequence which should pair after it is formed, base for base, with single strands of its parental DNA. This close pairing, or molecular hybridization, can occur through a technique by which a mixture of RNA - DNA is heated above its melting point and then gradually cooled. If the base sequences in this mixture are complementary, cross-fitting double strands are formed which are retained on special filters that permit single strands to pass through, and which also protect the RNA from the degenerative action of the ribonuclease enzyme.

III. RNA TRANSCRIPTION

All RNAs in the cell except for those in RNA viruses are synthesized from a DNA template. This process is called transcription. The enzyme that carries out this process is called DNA-dependent RNA polymerase or RNA polymerase. In contrast to DNA polymerase, which requires a template and a primer, RNA polymerase requires a duplex DNA template, but not a primer to initiate RNA synthesis and can catalyze the linkage of the two initial ribonucleotides. Most RNA biosynthesis occurs in an asymmetric fashion in which only one of the two complementary strands of DNA is copied into RNA. The RNA product or transcript is synthesized in the 5' to 3' direction, resulting in the presence of a 5'-triphosphate end. Thus, all known nucleic acid polymerases synthesize their products in the 5' to 3' direction.

The initiation of RNA synthesis on the DNA template does not occur at random locations, but at very precise sites on the DNA called promoters. Promoters are short segments of DNA that contain the information for binding RNA polymerase in a specific manner and generally precede the initiation point of

transcription for each gene or operon. An operon is a genetic unit in which the expression of several genes is controlled by single promoters. The initial base of the transcript is designated as the "1" position and the prokaryotic promoter covers approximately 60 base pairs of the DNA from positions -55 to +5. For most eukaryotic genes, the promoters also precede the +1 position, however, in some special cases, the information for binding RNA polymerase may occur far into the structural part of the transcript. In addition to the promoter site, there are several other types of sequence signals that either overlap or are near to promoters and that affect RNA to polymerase activity.

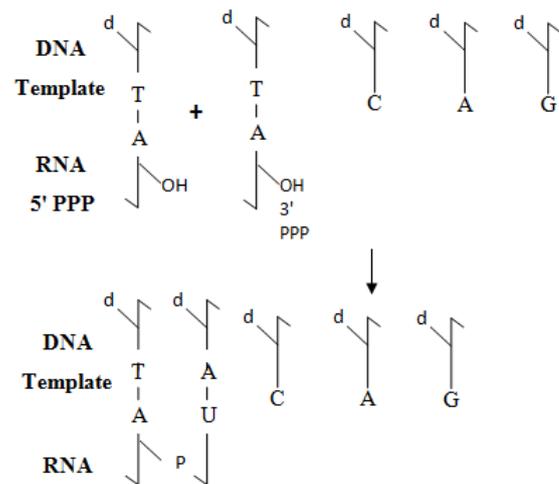


Figure 4: Transcription

IV. ECOSYSTEM AND ECOSYSTEM MANAGEMENT

Living organisms and their environment are in separable interrelated and interact with each other. Any unit that includes all the organisms in a given area interacting with the physical environment so that a flow of energy leads to clearly defined biotic structures and cycling of materials between living and nonliving components is an ecological system or ecosystem. The ecosystem is the first unit in the ecological hierarchy that is complete that has all the components necessary for survival. Accordingly, it is the basic unit around which to organize both theory and practice to ecology. Furthermore, as the shortcomings of the 'piece meal', short term technological and economic approaches to dealing with complex problems become ever more evident with each passing year, management at this level, this is called ecosystem management.

V. FOOD CHAIN IN ECOSYSTEM

The transfers of food energy from the producers, through a series of organisms (herbivores to carnivores to decomposers) with respect to eating and being eaten, are known as food chain. Producers utilize the radiant energy of sun which is

transformed to chemical form, ATP during photo synthesis. Thus, in any food chain, green plants occupy the first trophic level - the producer level, and are called the prime producers. The energy, as stored in good matter no manufactured by green plants, or is then utilised by the plant eaters the herbivores which constitute the second trophic level - level are called the primary consumers (herbivores). Herbivores in turn are eaten by the carnivores, which constitute the third trophic level - the secondary consumers level, and are called the secondary consumers (carnivores). These in turn may still be eaten by other carnivores at tertiary consumer (carnivores). Some organisms are omnivorous eating to the producers as well as the carnivorous at their lower food chain. Such organisms thus may occupy more than one trophic level in the food chain.

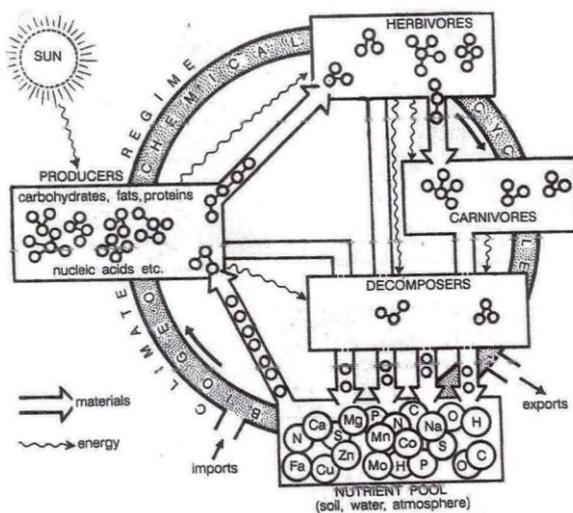


Figure 5: A generalised model of an ecosystem to show its structure and function. Note, the chemical cycles superimposed on the various components of the ecosystem, movement of materials in cycle manner, and that of energy in non-cyclic (unidirectional) manner.

(Sharma, P.D., 2013)

VI. CONCLUSION AND RECOMMENDATIONS

Nucleic acids are composed of a pentose, phosphoric acid, purine bases (adenine, guanine), and pyrimidine bases (thymine, cytosine, uracil). They are linear polymers of nucleotides linked by phosphate - diester between the pentoses. Since one acid group is left free, nucleic acids are very acidic and bind to basic proteins. In eukaryotic cell's DNA is bound to histone, forming a nucleoprotein structure called chromatin. DNA differs from RNA in the pentose (deoxyribose in DNA, ribose in RNA) and in one of the pyrimidine bases (thymine in DNA, uracil in RNA). As shown in the figure the nucleic acids are also circulated with other nutrients and energy in the food chain of the ecosystem, The metabolic reactions are also circulated with the circulating the nucleic acids in the food chain of the ecosystem.

The rapid advances and technology have put the scientists and technologists on their heels to cope up with the simultaneous changes that have occurred during the past decades. Various types of revisions, rectifications as well as modifications and sometimes even together innovated ideas that developed in numerous fields of specializations have required to be incorporated with the advanced to the concerning field of the study. The innovative techniques have put the researches consistent think and rethink level on entertain high concepts related to the life science. The study of such concept as nucleic acids are to be considered with their reactions flow in ecosystem of land aquatic, mountains, deserts, and their flow in ecosystem of land, aquatic mountains, deserts and air etc. and interrelationship in between plants, animals and their habits and habitats.

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