

REVIEW ARTICLE: IMPACT OF MOLECULAR BIOLOGY IN LIFE SCIENCE

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ABSTRACT:

To study and understand the mechanism of living systems, and how it works, it is quite important to investigate it at molecular level (like genomic, proteomic) as well as the methodologies, and how to apply and imply it on different branch of sciences and how can use it in developing medical diagnosis, treatments, drugs, and increased it in the future. Additionally it can also be applied in forensic techniques, food production and agriculture, as well as genetic profiling. This can be well understand by interfering and combinations of all branches of life sciences such as chemistry, physics, biotechnology, genetic evolution, and minimize the gap between them, this will enable the researchers and the scientists to understand the genomes diversity, information of genes, as well as cells of features.

Keywords: Molecular biology, genomics, DNA, RNA,

INTRODUCTION:

Molecular biology is a branch of science that deals with biological activities in living things at molecular level, this involves it from end to end to explain and investigate the phenomenon that occurs in living creatures. The expression Molecular Biology was made up in the thirties of the last century by a scientists named Warren Weaver, and was supported in 1933 by another scientist (Rockefeller) and the term was globally used during the World War 2, which direct the scientists to interfere this science with other sciences, precisely the life

sciences using a certain programs and using new methods and instruments, for example, electron microscope (which discover the viruses, XRC (X-Ray Crystallography, which determine the structure of proteins), electrophoresis, centrifuges, which were used to study the structures and the distribution of the large molecules inside the human body such nucleic acid, and proteins⁽¹⁻⁴⁾.

In the forties of the last century the macro molecules were studied biologically through and by a specialist in biochemistry and deal with these molecules using molecular weight, and interfere this with another field called biophysics and associated it with a different field called "Physiology"⁽⁴⁻⁷⁾.

After the Word War II, there was a great interest by the biologists to associate other branches of science with biology, especially physics and make it useful to mankind and can be applied peacefully, and they were supported and funded from two main and big research centers; National Institutes of Health, and National Science Foundation, these funded researches were ended with establishing new field in physics called "Biophysics" and connected it with other branch called radiobiology through a certain radio elements called radioisotopes, which play a main role in the fifties of the last century⁽⁸⁻¹⁰⁾.

New procedures and methods were established by chemists to determine the protein structure and discover the DNA sequence, and this field was described and named as "Molecular Biology" and sometimes it was named as "Biophysics" due to the usage of physics instruments, but now, this field of study called Molecular Genetics", which care about the

bacteria and viruses, isolate and characterized, and purify them, this field was the main interest of two researchers between 1950 and 1960, Francis Crick and James Watson, they reached that the gene consist of two helixes (double-helical) and build of not proteins but nucleic acid ⁽¹¹⁻¹³⁾.

In the mid of sixties of the last century, the scientist focused on solving the gene coding and determine the nuclear acid sequence (encoding) and their functions, while in the seventies they start to study the circumstances by which bacteria and viruses genes can be activated and how to control their problems, and from that time and on the expression of molecular biology becomes more familiar and common and DNA and RNA were appear in the biological sciences and they develop techniques and instrument to identify their sequence. However, in the nineties, a new field and a very important come in the biology science called "Genetic Engineering", which combined with medicine which study the biological phenomena that related with it as well as the diseases and modification in genes ^(14, 15).

Molecular biology focused on mechanism of macromolecules in living creatures, this involve this field to study in details for example for gene, it focus on its nature, mutation, replication, and how to express it, and to get a clear picture, the molecular biologist need to have knowledge in different and many related sciences, such as, biochemistry, physics, mathematics, cell biology, organic chemistry, and many other fields of science to enable the biologist to integrate the technique ⁽¹⁶⁾.

The relationship between molecular biology and other science is widely associated and related due to its interference with most sciences, however the upcoming following pages will discuss briefly about the association and the impact of molecular biology with other

sciences.

Association and the impact of molecular biology with chemistry & biochemistry:

The knowing of life basis is usually starts with the structures and the living matter components, and the most important substance is the protein, as well as the chemical processes that occurs inside the living cells which usually follow the chemical roles, laws, and theories, precisely hydrocarbons, and complex compounds which were prepared and synthesized inside the living cells, and to achieve these bio reactions completely there must be a catalyst that play a very important role, in biosynthesis, the catalyst is a very complex compound called Enzyme ⁽¹⁷⁾.

The effort of chemists was start to understand the compositions of proteins and enzymes and then understand what is called biochemical reaction (the biochemistry of the cell) ^(18, 19).

In 1800, Frederich Miescher, a Swiss scientist, he was biochemist and he was the first one who experientially observed the DNA which has the chemical formula $C_{232} N_{92} O_{139} P_{22}$ and he reached the magnitude of the DNA in the cell, genes, and in life in general, this will eventually leads to understand the mechanism of two main concepts in molecular biology named phenotype and genotype ^(20, 21).

The discovery of DNA structure was registered in the name of Francis Crick and James Watson who awarded the Nobel Prize in 1953; they reached this conclusion by using X-Ray Crystallography technique. This discovery open and announced the beginning of new and a very specific and modern field in biology named molecular biology. Using biochemistry as approach to characterize and encodes the genes, reaching synthesis, purification of genes, and this investigation can be achieved and carried out in the lab ware "in vitro", but at the

same time it does not give a clear picture of what happen in the living cell inside living features ‘in vivo’, which could be different than in vitro (21, 22).

However, both studies are required and needed and by combining both studies will enable the researchers to predict a strong and solid conclusion. In general cells consist mainly from certain chemical compounds such as; proteins, lipids, carbohydrates, cholesterol, glycoproteins, phospholipids. For carbohydrates the monomer unit is monosaccharide which mainly consist of carbonyl and hydroxyl groups, while for proteins it is amino acids (which consist of carboxylic acid, and hydroxyl groups), and as for nucleotides is nucleic acids (which consist mainly from monosaccharide, phosphate, base, and either ribose/or deoxyribose) (21-23).

Chemists nowadays are able to synthesize thousands of organic compounds in their laboratories and away from living cells, and using synthesized enzymes as catalysts in the reaction, as well as characterized, identified, and study their bonds, structures, behaviors as well as the functional group in the crystal structure using XRD (X-Ray Diffractometer), and with XRD, which confirm the three dimensions structure of the compound and through this it will be possible to find the length of the bond, the electro-negativity, the electron density, angels between atoms, components of the molecule and much more (24). Proteins molecules are the most important compound in molecular biology researchers, because from proteins, enzymes can be synthesized, proteins is main compound in structure of the cells, it can regulate and control the processes in the cells, and also they can transfer small molecules and signals from and to the cells (24).

Nucleic acid:

It is considered as the main unit of the

cell in the living creatures, due to its important to know the mechanism of the processes in cell and life in general, it is a large molecule and can linked with each other to form a chain to present RNA and can take different shapes (not only chain form), and the combination of 2 chains will form the DNA (double helix shape) (25).

The importance of the nucleic acids is because it has and carried all the information of the genes that were comes from parents to their children, the combination of nucleic acid with proteins will form the ribosomes, which has the ability to twist, rotate and turn the instructions of genes from one protein to another one. Because of the double helix shape of the DNA, it looks like stair in a spiral appear, the 2 rails symbolize the two threads which comes jointly and they are jointed together with nucleotide (like step in the ladder) and are represented in codes, and there are mainly four genetic code which are A (Adenine), C (Cytosine), G (Guanine), and T (Thymine), U (Uracil, in RNA) (25, 26). The scientific name of the DNA backbone is “2’-deoxyriboses, that joined by the bonds of 3’-5’ phosphodiester, figure 1 A, shows the difference between RNA and DNA.

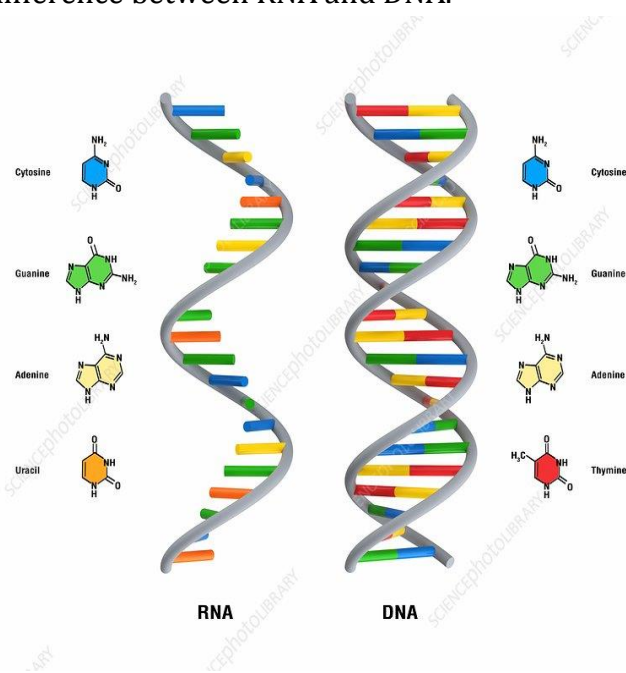


Figure 1: Differences between RNA and DNA Structures (23)

Usually, each DNA has a code sequence, which can be detected by certain physico-chemical instrumentations, this process (sequencing of DNA), is carried to find out the individual gene sequence of every organism, such as chromosomes, cluster, entire genome, and operons, it is also very important and considered as very efficient method to find the sequencing of RNA, and reach the sequencing of proteins. In fact the sequence of the DNA is very useful and widely used as successful method in forensics, biology, anthropology as well as medicine (27).

The code of sequence of the DNA is also very useful and widely used and important in molecular biology because it can give information about proteins, and genomes encode, this information can enable the researchers and the scientists to recognize the changes, alteration and the mutations in genes that has relation and associated with phenotypes, and diseases, which eventually reach the targets in identifying a suitable drugs and treatments. Figure 2 shows the building blocks of DNA (23).

Relationship between molecular biology and cell biology:

The ability to predict the pairing becomes easier for the researchers and scientists to understand the mechanism of the DNA and how it works. In the duration of the division of cell, splitting up of the pairs will occur, and each part of the base will connect with different part which eventually will guide the process and leads it to the creation and construction of new cell. This will lead to develop a more specific field called Evolution Biology that deals with and explain the processes that connected with evolution; such as common descent, speciation, and natural selection, which are responsible for life diversity on earth; this field was created by Julian Huxley at thirties of the last century who established this subfield to understand and connect other sciences with it like paleontology, ecology, genetics, and systematic biology (a science that study the diversification in present and past living creatures, this will interfere with molecular evolution, genetic engineering and adaptation and other studied that participate and involved in evolution such as biogeography, genetic drift, and sexual selection which eventually create a new field called Evo-Devo (Evolutionary Development) which investigate the embryo and its development (28, 29).

The formation of proteins involve amino acids as a basic unit and there are twenty types of amino acids along with four basic units of DNA will leads to synthesize different types of proteins that are exist in the cells. Basically there are two types' cells, cells without nuclei called Prokaryotic cell, and cells with nuclei called Eukaryotic cell both of them have cytoplasm, DNA. However there are also major differences, such as complexity, size, and composition which eventually reflect and affect their functions (30).

Cells is the main unit that form tissues

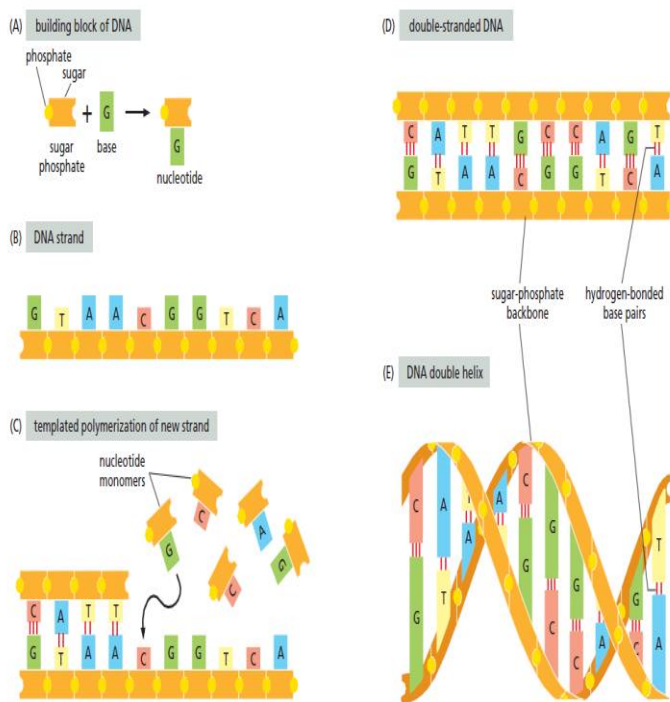


Figure 2: Building blocks of DNA (23)

and combining these tissues will form the organ, but each cell work independently and can replicate and react with other cells in the organism. In cell biology the researchers work on cells level, but in order to get a better understanding, they must correlate with molecular level, precisely, correlate with molecular biology ⁽³¹⁾.

Important concepts used in molecular biology:

Recently, researchers pay attentions and concentrate of a certain concepts that must be used in molecular biology in order to enable them to get better understanding and classify the information collected from the researchers ⁽³²⁾.

Mechanism:

It is important of the molecular biology research to know and understand this concept which is widely used in many processes such as replication of DNA, gene expression, synthesis of proteins, and much more.

Mechanism concept was approved and recommended by a lot of researchers such as Machamer et al. in 2000 ⁽³³⁾, and in 2013 diagram mechanism was recommended by Carver and Darden ⁽³⁴⁾ in order to get better and clear knowledge, because mechanism explain how things work, and also give you a fiction to predict based on the available knowledge, this can be applied in many biological processes such as pairing of DNA, in addition to that from mechanism scientist can suggest a new root, which eventually can change and control the experimental tools. Mechanism can be represented as a scheme that described in diagram which is known as "Mechanism Model, or Scheme Mechanism", for instance, the scheme that was introduced by in 1965 by Watson ⁽³⁵⁾, which considered as central and vital view and main principle in Molecular

biology because it describes the components and activities:

DNA → RNA → Protein

Above is a very simple scheme that depict the protein synthesis, also it indicates the sequence of the synthesis process, like from DNA, RNA was synthesized, and from RNA protein is synthesized, this can explained why molecular biology text books are filled of schemes and diagrams ⁽³⁶⁾.

Information:

Information can be appears and noticed often in molecular biology, for example the sequence that are noticed in DNA and RNA give a clear information and can predict and translated to the protein in protein synthesis, these information can be transferred from one generation to other via genes, these information are widely used by biology scientists and researchers.

In 2006, Stephen Downes ^(37, 38) differentiate main points such as; Sequences in RNA, DNA, as well as nucleotides, and the Information received from above point can explain the mechanism of proteins synthesis in cell, this information can guide the research no matter what is the status, the environment especially in discovery and development. And by using this information researchers can determine and predict the outcomes from any cellular process as well as its steps through translation, replication and transcription of gene coding. Not only that, but also can count and predict the possibility of errors which eventually leads to mutation and the changings that possibly occurs to DNA ⁽³⁸⁾.

Gene:

Gene refer to molecular biology, and understanding this concept develop the mechanism and the information received from genes leads to figure out the expression of

genes, and can be distinguish one gene from other and can determine its structure as well as its function and named them in a short expression such as Gene-D (which is related to resources development), and Gene-P (which is connected and has relation with genotype) and both of them can be distinguished from their sequences ⁽²³⁻²⁶⁾.

CONCLUSION:

- Molecular biology is a study that focuses on the determination of the sequence of RNA, DNA, and proteins.
- Encoding the genes can draw the mechanism of the protein synthesis process.
- Information received from gene encoding, proteins synthesis can plot a scheme to predict the outcomes of any cellular process.
- Molecular biology provide information of issues such as explanation, reduction experimentation and extrapolation.
- Molecular biology interfere with different fields of science such as biochemistry, genetics, cell biology, biology, biophysics, crystallography as well as computational biology, structure of proteins and its physical and chemical properties and much more.

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