

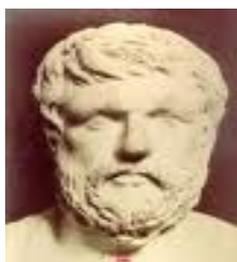
Thoughts on the Historical Discovery of DNA

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Introduction: The discovery according to the Greek philosopher Xenophanes (6th B.C.) is a “gift donated to humans by God(s) who liked not to reveal everything to them but allow them to apply research in order to invent the best” (Figure 1). Indeed, the human history is characterized by small and great discoveries that promote knowledge and civilization.



«ἀπ' ἀρχῆς πάντα θεοί θνητοῖς
ὑπέδειξαν
ἀλλὰ χρόνῳ ζητοῦντες
ἔφευρίσκουσιν ἄμεινον»

Figure 1: According to the Greek philosopher Xenophanes (6th B.C.) research is a God gift for humans to invent the best.

For example, the discovery of fire advanced their quality of life. With the use of fire our ancestors could face the chilly winter and prepare indispensable tools for agriculture and fishing. With fire unfortunately they could also kill their civilizations and natural environment. We, the residents of Greece, enjoy in the winter the warm of fire but in summer we realize its power and fear when it destroys the woods and houses and spreads the death to the plants, animals and humans. Similarly, the discovery of gas and nuclear energy are beneficial to humanity for providing energy in order to have a comfortable life. Gas can provide also the starting materials for new technological products and drugs beneficial to our health. However, gas and nuclear power are reasons for nations to make wars and destroy the environment and human lives. Humanity resembles with the mythological Prometheus that his flesh is eaten by vulture (own sins) (Figure 2).



Figure 2: *People use the discoveries like fire not only for advancing their quality of life but also to kill their civilization and natural environment. Humanity resembles with the mythological Prometheus that his flesh is eaten by vulture (own sins).*

Highlights on the biography of James Watson: The visiting of the invited speaker James Watson at the University of Patras by Professor John Matsoukas who also assigned me to give an honored speech revived my previous thoughts about discovery. I imagined myself in the middle of the ship travelling a journey to explore a recent discovery that leads in the course of history the humanity to the light and that leaves helical traces that reach the heavens. I wished this discovery brought peace to the humanity and people shared their respect by joining their hands (Figure 3).



Figure 3: *The dreaming for a journey that leads to the light and people sharing their respect by joining their hands in a double helix.*

Here are given the major highlights of my speech. Today, Greece hosts the father of two children, the teacher and humanist and excellent scientist James Dewey Watson. James Watson shared the highest scientific distinction with Francis Crick and Maurice Wilkins, the Nobel of Physiology and Medicine in 20.10.1962 (1,2) "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material".



Figure 4: *The three Nobel winners Francis Crick (left), James Watson (middle) and Maurice Wilkins (right)*

As far as I am concerned the academic personnel of University of Patras should feel proud of Professor J. Watson being today (11.4.2011) honored as emeritus doctor, the already honored by plethora of awards emeritus. I strongly believe that all academic personnel and scientists of Greece have also the same feeling (Figure 5).



Figure 5: *Nobel Prize winner J. Watson is honored as emeritus doctor by the Academic Personnel of the University of Patras.*

James Watson was born in 6th of April 1928, in Chicago, Illinois of USA. When he was 15 years old he was accepted in the Department of Zoology in the University of the same state. At the beginning he showed strong interest in ornithology. The book by Erwin Schordinger "What is life" where it is mentioned that genes are carriers of heredity changed his research interests and finally led him to the discovery of double helix. After completing the undergraduate studies in 1947 continued his education and received his Ph.D. in 1950 from Indiana University under the supervision of Salvador Edward Luria (1912-1991). E. Luria was a distinguished research personality and shared a Nobel Prize for his work with Max Delbrück, on the Luria-Delbrück experiment, which is related to the nature of genetic mutations. E. Luria and M. Delbrück were among the leaders of "Phage Group", an important

movement of geneticists, who made use of the viruses that infect bacteria, called bacteriophages (phagos means the one that eats in Greek language).

Watson then went to Copenhagen University for post doctoral research for a year to work in the laboratory of biochemist Herman Kalckar. Kalckar's research interests focused on the enzymatic synthesis of nucleic acids, and he would use phages as an experimental system. These research interests did not coincide with Watson's who wanted to explore the structure of DNA. For this reason, thus Watson spent part of the year in Copenhagen conducting experiments with microbial physiologist Ole Maaloe, then a member of the Phage Group. J. Watson during his working with Kalckar, was lucky enough to visit Italy and listen to a speech by Maurice Wilkins who talked about the crystallographic structures of nucleic acids. This speech increased further his willing to study DNA and the way this is copied. Meanwhile, Oswald Avery (1877-1955) discovered that DNA is responsible for transferring the heredity and Erwin Chargaff (1905-2002) the rules of pairing of DNA bases, thus purine adenine pairs with thymine and pyrimidine guanine with cytosine. These discoveries led him to the decision to move to the famous Cavendish laboratory of Oxford England where X-rays are used as a tool for the structure determination of three dimension structure of bioactive molecules.

Salvador Edward Luria arranged for John Kendrew (1917-1997) to meet James Watson. John Kendrew is absent from the laboratory in a trip and Max Perutz (1914-2002) took the responsibility to meet James Watson. I do not mention accidentally these names. Kendrew shared in 20.11.1962 the Nobel Prize for Chemistry with Perutz for determining the first atomic structures of proteins (myoglobin and hemoglobin correspondingly) using X-ray crystallography (the same day they received the Nobel Prize Watson, Crick and Wilkins). It appears that Watson everywhere he was going was meeting Nobel Prize Winners (Figure 6). It is also worth mentioning that in the laboratory of Cavendish he worked, famous scientists and inventors as J.C. Maxwell, Lord Rayleigh, J.J. Thompson and E. Rutherford exerted research activity. The time he arrived in Cavendish laboratory, director was Sir Lawrence Bragg who also received Physics Nobel Prize with his father Henry for their work in X-ray crystallography.

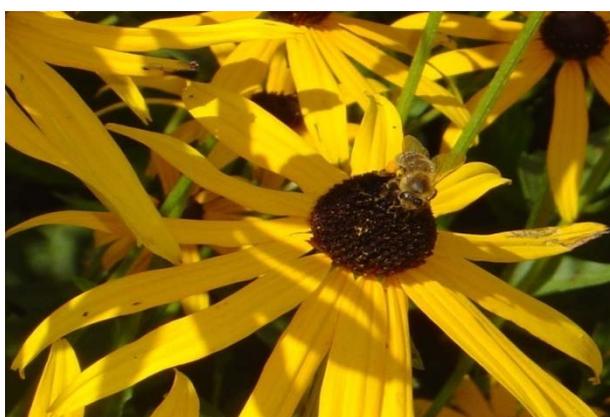


Figure 6: *J. Watson resembles a bee that stores knowledge for discovering the structure of the double helix of DNA, recognized as one of the most important discoveries.*

In the laboratory of Cavendish James Watson met the physicist Francis Crick who changed research interests towards biology and he was pursuing Ph.D. studies in the x-ray crystallography of proteins. With him, James Watson started an intensive effort to determine the crystal structure of DNA using molecular models. This effort is supported by the physicist Maurice Wilkins who was working in the Royal College of the University of London. Maurice Wilkins provided James Watson and Francis Crick with the DNA-B form crystallographic data obtained by the distinguished scientist Rosalind Franklin. Their efforts are further intensified as their competitor Nobel Prize Winner in Chemistry (1954) and Peace (1962) Linus Pauling (1901-1994) published the wrong triple helix structure of DNA.

From the so far story towards the discovery of DNA two wise teachings must be mentioned:

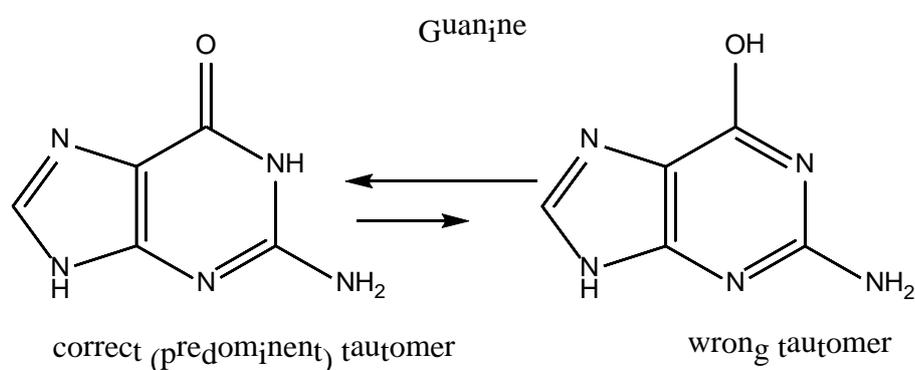
(a) Even top scientists as L. Pauling can make a scientific mistake. These mistakes do not reduce their great contribution to the science. The mistakes usually work in favor of the scientific truth. Scientists do not rely on the name but the actual validation of the scientific truth. James Watson and Francis Crick realized immediately the mistake of Linus Pauling and this was a driving force to discover earlier the structure of DNA.

(b) Every great discovery has behind a lot of other contributors. The existing knowledge helped James Watson Francis Crick and Maurice Wilkins to discover the structure of DNA. Without the experimental data provided by Maurice Wilkins and obtained by Rosalind Franklin it is sure that the discovery of DNA would come later.

J. Watson and F. Crick failed at first to pair with a right way the bases of DNA. Fortunately, a visit of Jerry Donohue to their laboratory gives a solution to their problem. He explains them that bases exist in keto form and not enol as it is proposed in educational books and applied to their metallic models. Here it comes another wise teaching.

(c) Scientists must be opened to the new knowledge. They must try the new ideas which may lead to new successful avenues.

Indeed, when the two scientists followed the hint of J. Donohue the success has come very early (Figure 7).



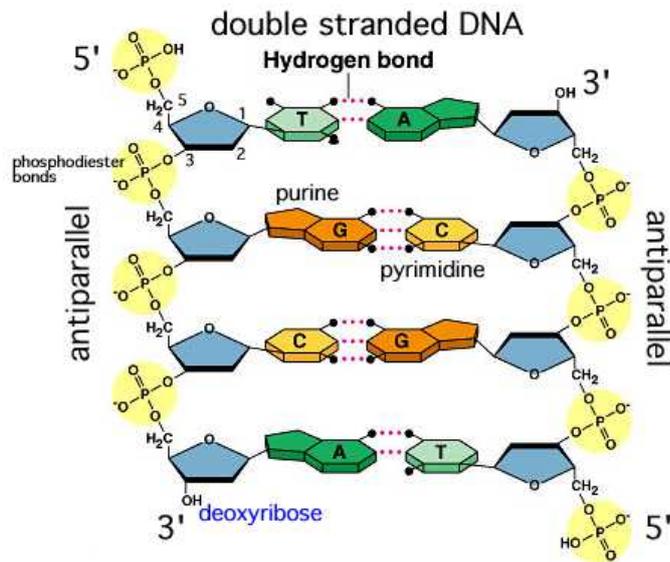


Figure 7: The correct and wrong tautomers for the Guanine base of DNA (top). The way DNA bases interact in a part of a helix (down).

In 28.2.1953 J. Watson and F. Crick succeeded to pair in a correct way the bases of DNA and revealed that DNA has a structure of double helix. This structure can explain the copy of the genetic material. One of the greatest achievements in the world has been accomplished and Watson as a new Archimedes shouts EUREKA-EUREKA (Greek word that means I found it) (Figure 8).



Figure 8: The great discoveries are characterized by EUREKA-EUREKA. On the left is shown J. Watson and on the right Archimedes.

This discovery will lead to new scientific horizons for the humanity, an «ANOSIS» (Anosis is the force that leads objects to float. Unfortunately, the word «anosis» does not exist in the English language. The law of anosis is written as the law of flotation). A floating object displaces its own weight of the fluid in which it floats). Molecular Biology, Medicine,

Genetics, Genetics Mechanics and Biotechnology developed tremendously because of the discovery of the structure of DNA.

The scientific work on the structure of DNA is published in the top scientific journal Nature on April 25th and May 30th of 1953 [1,2]. In the first chronologically short publication it is explained in a succinct way the scientific discovery. For the first time the authors formulated a relationship between structure and bioactivity. The structure of DNA is responsible for the way that it copies the genetic material. Today, this relationship is recognized for all scientists who are working on biological and pharmaceutical sciences (Figure 9).

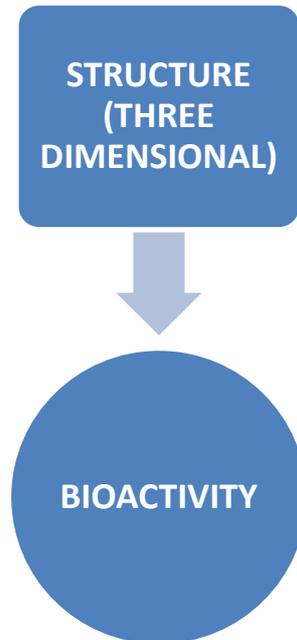


Figure 9: *The relationship between structure and bioactivity was first recognized in the article entitled “Molecular Structure of Nucleic Acids” published in Nature by the authors J. Watson and F. Crick on April 25th of 1953.*

The dilemma of who will be the first in the publication is left to the “coin” to decide. This is another important wise advice for the action of the two co-authors.

(d) When there is no sign of who has contributed most in a scientific article, then the decision is made from “a not controlled but fair factor”. This is the best decision that leaves happy the scientists and causes no conflicts.

James Watson served after the discovery of DNA (1956-1976) as a Professor at Harvard University teaching Molecular Biology in Cambridge of Boston in USA (Figure 10). From 1968 to 2007, he served as director, president and provost in the laboratory of Cold Spring Harbor of Long Island. Today, he is an emeritus provost of the same laboratory. His research activities focus in the use of Genetics for the cure of cancer and brain diseases.

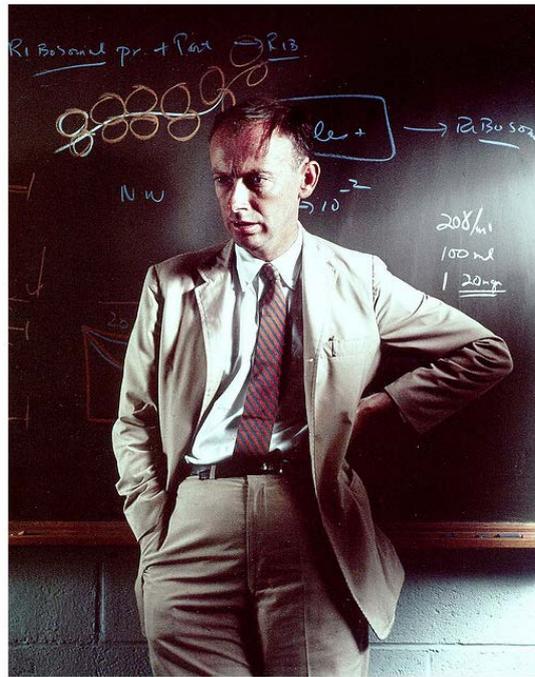


Figure 10: *J.D. Watson portrait at Harvard University of Cambridge, USA (1964)*

It is important to say that he has been involved in the programme for establishment of human gonidioma (1988-1992). However, he had to step down because he argued with the Head of National Institute of Health, USA regarding the free access of gene sequences. James Watson disagreed that private patents should be issued for the gene sequence. He wanted the scientific knowledge to be opened and easily accessible to all scientists.

(e) This is another message from his life. Scientists and especially academics should not see scientific knowledge as a means of being rich. They should help to be spread out and become available with the lowest cost to those scientists who are interested in building new research eras in scientific knowledge.

James Watson was a lover of piece and argued about the involvement of USA in the Vietnam war. He argued also in the utilization of nuclear energy by private people. James Watson believed that scientific research in Genetics will lead finally to the cure of cancer. He is convinced that the right applications of DNA discovery will lead to the decrease of human pain [3,4]. This optimism of James Watson makes us to think that in spite of the fact that DNA discovery nests bioethics and eugenics problems which the lawyers try to solve, it constitutes probably the greatest of all discoveries that can provide humanity with light. I remind you that we travel in a ship and we are looking for the light that leads to the eternal life of love (Figure 11).

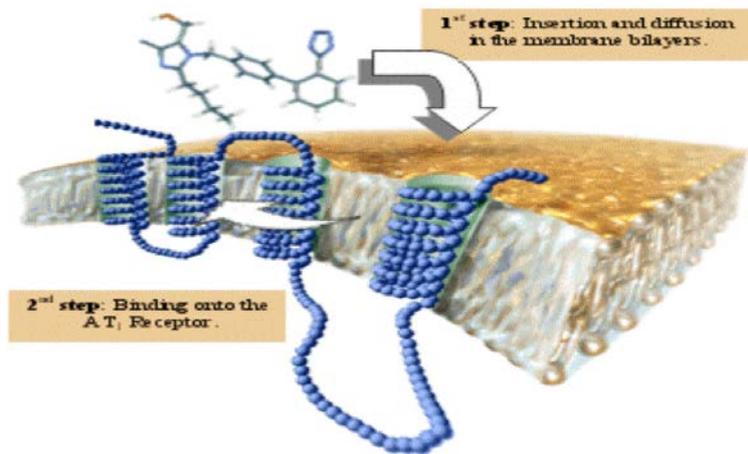


Figure 11: *Helices are everywhere in the biological environment*

I would finish this short presentation on James Watson saying this optimistic dictum: I am pretty convinced that discovery of DNA and the next to come related to DNA scientific research have all the requirements that can lead to humanity in the real light of happiness (Figure 12).



Figure 12: J. Watson with some students of Patras University

References.

1. Watson J.D. and Crick F.H.C.: A structure for Deoxyribose Nucleic Acid. Nature 171: 737-738 (1953)
2. Watson J.D. and Crick F.H.C.: Genetical Implications of the structure of Deoxyribonucleic Acid. Nature 171: 964-967 (1953)
3. Watson J.D.: A Geneticist's Cancer Crusade. The Wall Street Journal: The Weekend Interview. November 27 (2010).

4. Information on Watson's life was obtained mainly by the books written by J.D. Watson entitled "Double Helix and "DNA the secret of life" and Wikipedia.