ID Design Press, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2019 Sep 30; 7(18):3096-3100.
https://doi.org/10.3889/oamjms.2019.767
eISSN: 1857-9655
Global Dermatology

DNA Waves and Their Applications in Biology

Massimo Fioranelli[1*], Alireza Sepehri[1], Maria Grazia Roccia[1], Chiara Rossi[1], Jacopo Lotti[1], Petar Vojvodic[2], Victoria Barygina[3], Aleksandra Vojvodic[4], Tatjana Vlaskovic-Jovicevic[2], Zorica Peric-Hajzler[5], Dusica Matovic[5], Jovana Vojvodic[2], Sanja Dimitrijevic[6], Goran Sijan[7], Uwe Wollina[8], Michael Tirant[9], Nguyen Van Thuong[10], Torello Lotti[11]

[1]Department of Nuclear Physics, Sub-nuclear and Radiation, G. Marconi University, Rome, Italy; [2]Clinic for Psychiatric Disorders "Dr. Laza Lazarevic", Belgrade, Serbia; [3]Department of Biomedical Experimental and Clinical Sciences, University of Florence, Florence, Italy; [4]Department of Dermatology and Venereology, Military Medical Academy, Belgrade, Serbia; [5]Military Medical Academy, Belgrade, Serbia; [6]Department of Gynecology, Military Medical Academy, Belgrade, Serbia; [7]Clinic for Plastic Surgery and Burns, Military Medical Academy, Belgrade, Serbia; [8]Department of Dermatology and Allergology, Städtisches Klinikum Dresden, Dresden, Germany; [9]G. Marconi University, Rome, Italy; [10]Vietnam National Hospital of Dermatology and Venereology, Hanoi, Vietnam; [11]Department of Dermatology, University of G. Marconi, Rome, Italy

Citation: Fioranelli M, Sepehri A, Roccia MG, Rossi C, Lotti J, Vojvodic P, Barygina V, Vojvodic A, Vlaskovic-Jovicevic T, Peric-Hajzler Z, Matovic D, Vojvodic J, Dimitrijevic S, Sijan G, Wollina U, Tirant M, Van Thuong N, Lotti T. DNA Waves and Their Applications in Biology. Open Access Maced J Med Sci. 2019 Sep 30; 7(18):3096-3100. https://doi.org/10.3889/oamjms.2019.767

Keywords: Quantum Biology; Chick Embryo; DNA Wave; Bacterial DNA

***Correspondence:** Massimo Fioranelli. Department of Nuclear Physics, Sub-nuclear and Radiation, G. Marconi University, Rome, Italy. E-mail: massimo.fioranelli@gmail.com

Received: 02-Sep-2019; **Revised:** 14-Sep-2019; **Accepted:** 15-Sep-2019; **Online first:** 11-Sep-2019

Copyright: © 2019 Massimo Fioranelli, Alireza Sepehri, Maria Grazia Roccia, Chiara Rossi, Jacopo Lotti, Petar Vojvodic, Victoria Barygina, Aleksandra Vojvodic, Tatjana Vlaskovic-Jovicevic, Zorica Peric-Hajzler, Dusica Matovic, Jovana Vojvodic, Sanja Dimitrijevic, Goran Sijan, Uwe Wollina, Michael Tirant, Nguyen Van Thuong, Torello Lotti. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0)

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Abstract

AIM: In this research, we show that DNA waves have many applications in biology. DNA is formed by the joining of quantum particles like electrons and charged atoms. DNA has different motions during transcription, translation, and replication, in which the charged particles move, accelerate, and emit waves. Thus, DNA could emit quantum waves.

METHODS: Two methods are proposed to observe the effect of DNA waves. The first proposed method measures DNA waves emitted by bacteria suspended in the milk. The vessel of milk is placed in the interior of an inductor. One side of the vessel is connected to a generator and another side to a scope. By sending a current to the inductor, an input electromagnetic field is produced. Bacteria interact with the input field, change it and produce new output signals. Using the scope, the output signals are observed and compared with the input signals. The number of DNA waves produced also depends on temperature.

RESULTS: At lower temperatures, bacterial replication is less, and fewer DNA waves are produced. Conversely, more bacteria are generated at higher temperatures, and more DNA waves are produced. The second proposed method acquires and images of DNA signals of chick embryos. In this method, a circuit is constructed that consists of a graphene or metal tube, generator, inductor, scope, DNA in the interior of eggs and DNA exterior to the eggs. Magnetic waves pass the interior and exterior DNA as well as the graphene. The DNA is excited and the exciting interior/exterior DNA exchanges waves. Some of these waves interact with electrons in the graphene tube, and a current is generated. Properties of the chick embryo DNA can be explored by analysing changes in the waves that emerge from the eggs.

CONCLUSION: It is concluded that DNA waves could be used extensively in imaging and provide for us the exact information about evolutions of DNAs interior of biological systems.

Introduction

Quantum biology is a field of science that explores the applications of quantum mechanics in biology. Erwin Schrödinger first coined the term "quantum mechanics" in biology and proposed the idea of an "aperiodic crystal" that contains genetic information in its configuration of covalent chemical bonds [1]. Also, he suggested that mutations could be explained by "quantum leaps". The term "quantum biology" was coined by Per-Olov Löwdin for this new field of science, when he introduced proton tunnelling as another mechanism for DNA mutation [2].

Quantum biology has many applications in the evolution and continuity of life. One application is to propose a model for DNA mutation. This mutation is, in fact, an error in the DNA code, which occurs during the copying of a DNA strand during cell reproduction. A DNA mutation model has been proposed in which a nucleotide may change its form through the process of quantum tunnelling. The changed nucleotide will lose its ability to pair with its original base pair, which will change the structure and order of the DNA strand [3].

This DNA mutation may be produced by exposure to ultraviolet rays and other types of radiation [4].

Another application of quantum biology in biological systems is to explain the mechanisms for vision and the involved scientific process of phototransduction. In this process, a photon is absorbed by a chromophore in a light receptor, which causes photoisomerisation. This change in structure induces a change in the structure of the photoreceptor and the resulting signal transduction pathways that lead to a visual signal [5]. This process is very rapid (< 200 femtoseconds) and has a high yield. Models have been proposed in which quantum effects shape the ground state and excited state potentials to achieve the visual signal [6]. Yet another application of quantum biology involves magnetoreception, in which animals can navigate using the inclination of the Earth's magnetic field [7]. This biological event can be described by the entangled radical pair mechanism in quantum mechanics [8], [9]. Other biological events, such as photosynthesis [10], [11] and enzymatic activity, have been described through the quantum field theory [12], [13].

In addition to these applications, some observations can only be explained by quantum biology. For example, Montagnier and his collaborators argued about the capacity of some bacterial DNA sequences to emit very low-frequency electromagnetic waves when extensively diluted in an aqueous fluid. The authors discussed that the genomic DNA of most pathogenic bacteria includes sequences that can create such signals [14]. Another study by the same group described the experimental conditions under which electromagnetic waves of low frequency can be emitted by dilute aqueous solutions of some bacterial and viral DNAs. Also, the authors observed this transduction process in living human cells exposed to electromagnetic wave irradiation and suggested a quantum field theory analysis of the phenomenon [15].

Given this importance of quantum biology in biological systems, its origin is important to consider. We have approached this issue by considering the structure of DNA. We demonstrate the involvement of quantum charged particles that join together. Due to the motion of these objects, their charged particles create electrical currents and emit electromagnetic waves. We suggest some mechanisms for applying quantum waves in imaging of DNA packages like viruses, bacteria, and embryonic cells.

The outline of the paper is as follows. In section II, we show that DNA is constructed from quantum particles and radiates quantum waves. In section III, we propose methods for detecting the signals of DNA inside the virus and bacteria. In section IV, we describe the use of quantum waves in imaging.

DNA quantum waves

In this section, we propose several reasons (1-5) why DNA could radiate waves.

1. Each DNA is formed from a base pairing between A (Adenine) and T (Thymine), and between C (Cytosine) and G (Guanine). A and G are constructed from hexagonal and pentagonal manifolds. T and C are hexagonal [16], [17]. Each of these manifolds is constructed from charged atoms like nitrogen and carbon, and electrons. The electrical charges of each base differ from the others. Consequently, the A-T and C-G base pairs form two types of electrical moments (Figure 1).

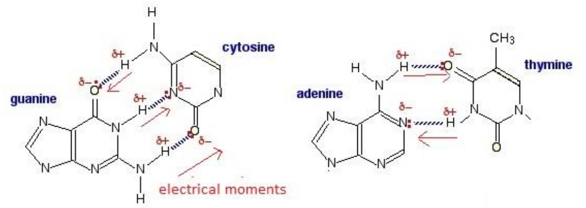

Figure 1: Each base in DNA is constructed from electrical moments

Moreover, different DNAs have different activities that cause the motion-related electrical charges and moments. For example, during transcription and translation, some regions of the genetic information on DNA are copied to form RNAs and proteins, which interact with DNA and lead to the motion of the DNA. According to the laws of physics, the motion of electrical charges produces a magnetic field and results in the emission of electromagnetic waves. Thus, each DNA can radiate various types of waves depending on the nature of its interaction with biological material like DNA and RNA (Figure 2).

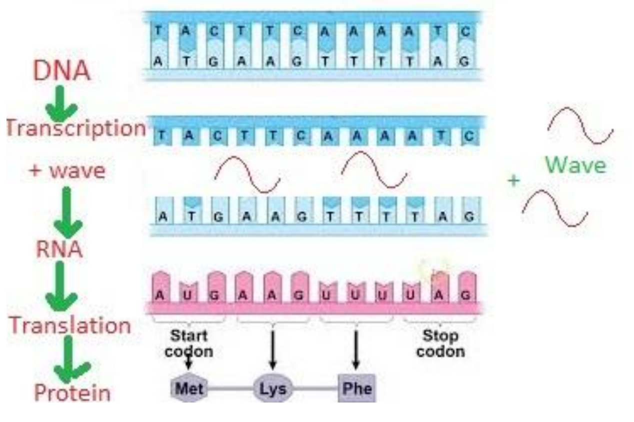

Figure 2: During transcription and translation, electrical pairs become separated, and some waves emerge

2. During cell division, the DNA in each cell replicates so that the two daughter cells have the same genetic information as the parent cell [18]. In this process, the two strands of the original DNA double helix separate and each strand's complementary DNA sequence is recreated as catalysed by DNA polymerase. In this mechanism,

charged pairs are separated and then joined to each other. Consequently, the motions of these charged particles produce electromagnetic waves (Figure 3).

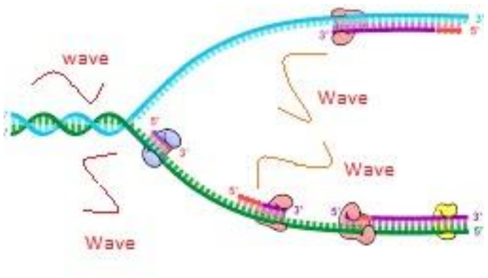

Figure 3: During replication, electrical pairs become separated, and electromagnetic waves emerge

3. The DNA structure is very similar to a solenoid or coil. Consequently, the motion of electrons the structure produces magnetic fields (Figure 4).

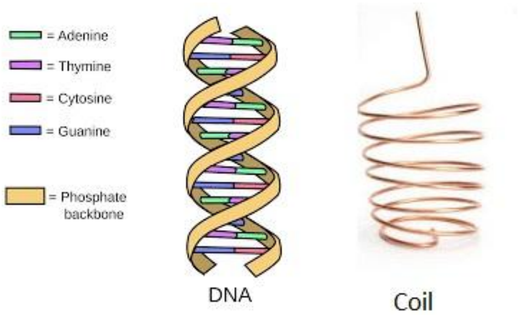

Figure 4: The structure of DNA is very similar to a coil

4. Each part of DNA acts similar to an electronic device. For example, hexagonal and pentagonal molecules store waves and energy and act as a capacitor. Coiled regions of DNA produce a solenoid. The collective circuits produce a system similar to a radio wave receiver or transmitter (Figure 5).

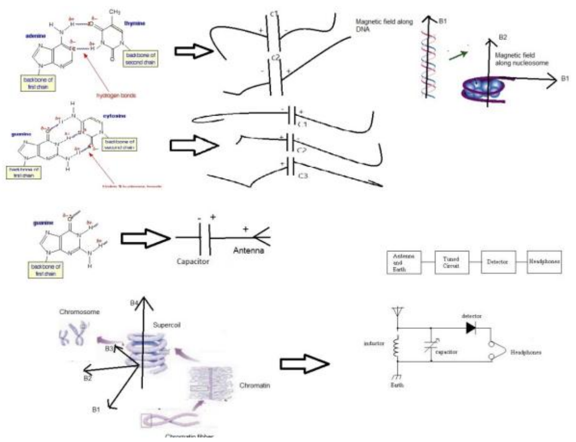

Figure 5: Each part of DNA acts similar to an electronic device [19]

5. Some waves act like topoisomerases and unwind DNA to allow reading of the information. Topoisomerases are enzymes that participate in the rewinding or unwinding of DNA. The winding problem of DNA arises due to the intertwined nature of its double-helical structure. Topoisomerases act on the topology of DNA [20]. Similar to these enzymes, some waves participate in the unwinding of DNA. These waves are coupled to the structure of DNA and produce topologically simple structures. This causes the exchange of information between DNAs (Figure 6).

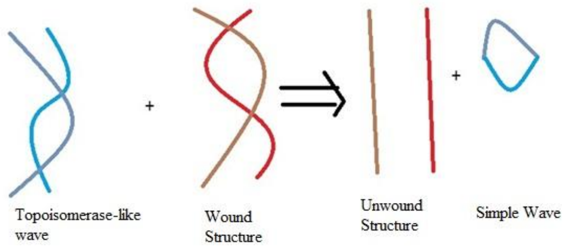

Figure 6: Topoisomerase-like wave couples to the wound structure of DNA and make it unwind topologically

A method for detecting waves of DNA packages like bacteria

To observe DNA waves, it is best to use biological versions of packaged DNA; virus and bacteria are suitable. When not packaged, DNA cannot undergo normal actions like replication and will not produce waves. For this method, bacteria and the viruses that infect them can be contained in a vessel that houses a fluid, such as milk, which can be used by the bacteria for growth. Also, since bacteria replicate autonomously, but virus do not (bacteriophage require bacteria to replicate), we need to bacterial packages. In this experiment, we didn't use the chemical medium and use of natural material like milk to show communication between DNAs and effects of DNA waves in a natural medium. In this procedure, a vessel of milk containing bacteria and virus were placed in an inductor. One side of the vessel was connected to a generator and the other side to a scope (Figure 7).

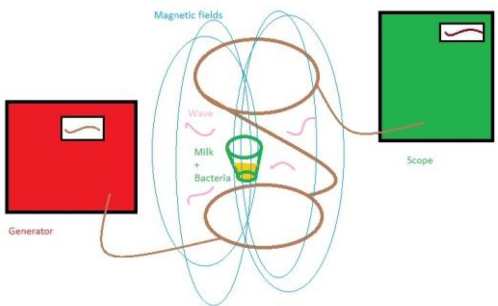

Figure 7: Detection of signals of DNA packages (bacteria) in a vessel of milk in an external magnetic field

A current is supplied to the inductor to produce a magnetic field. The bacteria and virus suspended in the milk interact with the magnetic field, alter it, and produce a new type of output electromagnetic field. The entire system can be placed in an incubator to observe the types of interactions between bacteria, viruses and magnetic field changes at different temperatures.

The signals obtained from bacteria growing at various temperatures are displayed in Figure 8. With time, the number of DNA packages (i.e., bacteria) in the milk increases, and more waves are emitted. The pattern depends on temperature. For example, at 5°C, fewer bacteria are produced, and fewer waves are detected, while more bacteria (and hence more waves) are produced at higher temperatures.

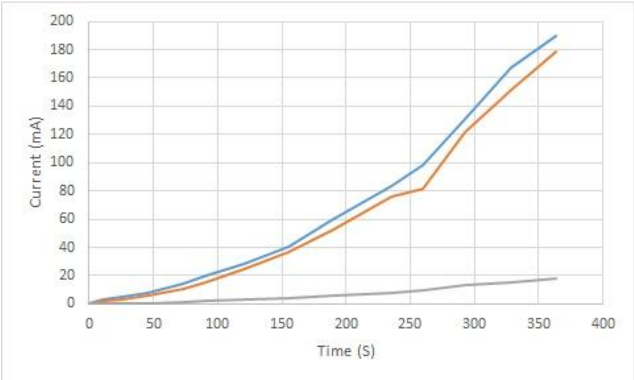

Figure 8: The growth signals of bacteria in milk in terms of time for 40°C (blue), 38°C (red), and 5°C (grey)

Use of DNA waves in imaging

The concepts of quantum biology and DNA waves can be exploited for imaging. For example, information about the properties of DNAs of chick embryos residing inside eggs might be obtained by analysing the waves exchanged between the DNA inside the egg with the DNA exterior to the egg. To this aim, we build a circuit from a graphene or metal tube, generator, inductor, scope, DNA in the interior of eggs, and DNA exterior to the eggs. Magnetic waves pass through the interior / exterior DNA, and the graphene. The DNAs are excited and exchange waves. Some of these waves interact with the electrons in the graphene tube, which generates a current. The changes that occur in these waves when exiting the eggs permit the analysis of the properties of the chick embryo DNA (Figure 9).

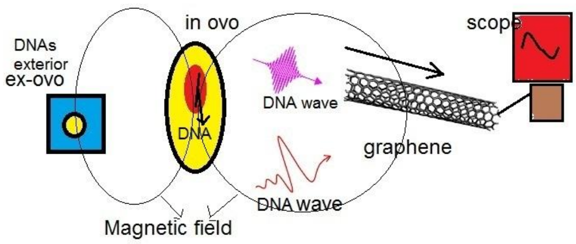

Figure 9: A circuit for using exchanged DNA waves between cells interior and exterior of egg in imaging

To obtain the exterior DNA, a culture system devoid of the shell was used for chick embryos. Similar to Tahara and Obara (2014) [19] and Sepehri et al., (2019) [20], [21], [22], a 450 ml polystyrene plastic cup was used as the pod for the culture vessel. A whole 1 to 1.5 cm in diameter was made at the side of the cup approximately 2 cm from the bottom, and a cotton pledget was installed in the hole as a filter. Then, a 2 mm diameter plastic tube was positioned in the space between the pledget and the hole to provide oxygen that was necessary for bacterial growth. A concave polymethyl pentene film was placed in the pod as an artificial culture vessel. A polystyrene plastic cover was put on top of the culture vessel. The vessel containing broken fertilised eggs was put in an incubator, and the shell-less cultures were incubated at 38°C and rotated 120° clockwise twice a day. After 54 h, initial cells of chick embryos were evident (Figure 10).

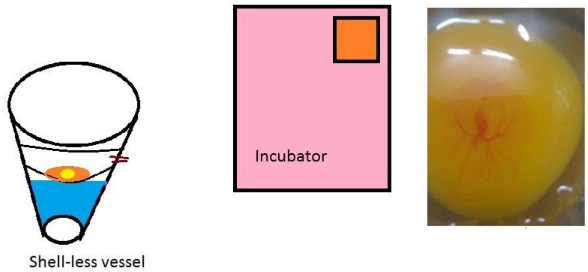

Figure 10: Incubation of shell-less cultures of chick embryos to observe the growth of cells

We explored whether the DNA waves that were generated could be used in imaging and to determine the gender of chick embryos. In Figure 11, the current value could distinguish males (red) and females (blue). The signal type differed between males and females. This is because that topology of some chromosomes in cells of males is different from the chromosomes of females. The motions of charged particles and electrons depend on the topology of the chromosomes and type of coiling, winding, and packing of DNA in them. Thus, by changing the shape of chromosomes and the DNA topology, ways and degrees of freedom of electrons change. Changing the motions of electrons changes their radiated waves, which explains the difference in the signals of males and females.

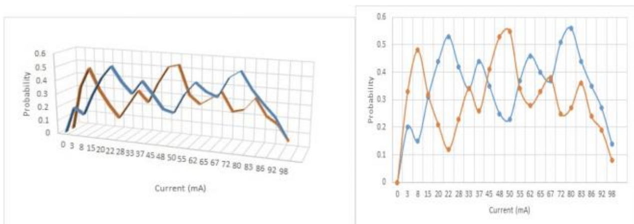

Figure 11: Comparison of signals of male (red) and female (blue)

In conclusion, in this research, we have shown that DNA waves play major roles in the evolution of biological systems. We propose two models for imaging by using concepts of quantum biology and DNA waves. The models are useful in charting bacterial growth and in distinguishing the gender of chick embryos.

References

1. Erwin Schrödinger. Cambridge University Press, New York, 1967:96. (Originally published in 1944.)

2. Lowdin PO. Quantum genetics and the aperiodic solid. Some aspects on the Biological problems of heredity, mutations, aging and tumours in view of the quantum theory of the DNA molecule. Advances in Quantum Chemistry. 1965; (2):213-360. https://doi.org/10.1016/S0065-3276(08)60076-3

3. Trixler F. Quantum Tunnelling to the Origin and Evolution of Life. Current Organic Chemistry. 2013; 17(16):1758-1770. https://doi.org/10.2174/13852728113179990083 PMid:24039543 PMCid:PMC3768233

4. Yu SL, Lee SK. Ultraviolet radiation: DNA damage, repair, and human disorders. Molecular- Cellular Toxicology. 2017; 13(1):21-28. https://doi.org/10.1007/s13273-017-0002-0

5. Johnson PJ, Farag MH, Halpin A, Morizumi T, Prokhorenko VI, Knoester J, Jansen TL, Ernst OP, Miller RD. The primary photochemistry of vision occurs at the molecular speed limit. J Phys Chem B 2017; 121(16):4040-7. https://doi.org/10.1021/acs.jpcb.7b02329 PMid:28358485

6. Schoenlein RW, Peteanu LA, Mathies RA, Shank CV. The first step in vision: femtosecond isomerization of rhodopsin. Science. 1991; 254(5030):412-5. https://doi.org/10.1126/science.1925597 PMid:1925597

7. Hore PJ; Mouritsen H. The Radical-Pair Mechanism of Magnetoreception. Annual Review of Biophysics. 2016; 45(1):299-344. https://doi.org/10.1146/annurev-biophys-032116-094545 PMid:27216936

8. Schulten K, Swenberg CE, Weller A. A biomagnetic sensory mechanism based on magnetic field modulated coherent electron spin motion. Zeitschrift für Physikalische Chemie. 1978; 111(1):1-5. https://doi.org/10.1524/zpch.1978.111.1.001

9. Kominis IK. The radical-pair mechanism as a paradigm for the emerging science of quantum biology. Mod Phys Lett B. 2015; 29(1):1530013. https://doi.org/10.1142/S0217984915300136

10. Lee H, Cheng YC, Fleming GR. Quantum coherence accelerating photosynthetic energy transfer. In Ultrafast Phenomena XVI. Springer, Berlin, Heidelberg, 2009:607-609. https://doi.org/10.1007/978-3-540-95946-5_197

11. Fujihashi Y, Fleming GR, Ishizaki A. Impact of environmentally induced fluctuations on quantum mechanically mixed electronic and vibrational pigment states in photosynthetic energy transfer and 2D electronic spectra. J Chem Phys. 2015; 142(21):212403. https://doi.org/10.1063/1.4914302 PMid:26049423

12. Nagel ZD, Klinman JP. Tunneling and Dynamics in Enzymatic Hydride Transfer. ChemInform. 2006; 37(43). https://doi.org/10.1002/chin.200643274

13. Nagel ZD, Klinman JP. Tunneling and Dynamics in Enzymatic Hydride Transfer. Chemical Reviews. 2006; 106(8):3095-3118. https://doi.org/10.1021/cr050301x PMid:16895320

14. Montagnier L, Aissa J, Ferris S, Montagnier JL, Lavallée C. Electromagnetic signals are produced by aqueous nanostructures derived from bacterial DNA sequences. Interdiscip Sci Comput Life Sci. 2009; 1(2):81-90. https://doi.org/10.1007/s12539-009-0036-7 PMid:20640822

15. Montagnier L, Del Giudice E, Aïssa J, Lavallee C, Motschwiller S, Capolupo A, Polcari A, Romano P, Tedeschi A, Vitiello G. Transduction of DNA information through water and electromagnetic waves. Electromagnetic biology and medicine. 2015; 34(2):106-12. https://doi.org/10.3109/15368378.2015.1036072 PMid:26098521

16. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Molecular Biology of the Cell (6th ed.). Garland. p. Chapter 4: DNA, Chromosomes and Genomes, 2014.

17. Watson JD, Crick FH. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. Nature. 1953; 171(4356):737-38. https://doi.org/10.1038/171737a0 PMid:13054692

18. Albà M. Replicative DNA polymerases. Genome Biology. 2001; 2(1):REVIEWS3002. https://doi.org/10.1186/gb-2001-2-1-reviews3002 PMid:11178285

19. Sepehri A. A mathematical model for DNA. International Journal of Geometric Methods in Modern Physics. 2017; 14:11. https://doi.org/10.1142/S0219887817501523

20. Champoux JJ. DNA topoisomerases: structure, function, and mechanism. Annual review of biochemistry. 2001; 70(1):369-413. https://doi.org/10.1146/annurev.biochem.70.1.369 PMid:11395412

21. Tahara Y, Obara K. A Novel Shell-less Culture System for Chick Embryos Using a Plastic Film as Culture Vessels. Journal of Poultry Science. 2014; 51(3):307-312. https://doi.org/10.2141/jpsa.0130043

22. Sepehri A, Fioranelli M, Roccia MG. The role of entropic penalties of circular DNA assembly in spectroscopy and imaging. J Theor Appl Phys. 2019; 13(1):39-47. https://doi.org/10.1007/s40094-019-0321-8