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STUDY OF THE "BIOCOMPUTING TECHNOLOGY" AS AN APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) IN SECONDARY SCHOOL CURRICULA IN EGYPT

دراسة تكنولوجيا الحوسبة الحيوية " كتطبيق للذكاء الاصطناعي في مناهج المرحله الثانويه فى مصر"

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Abstract

A biocomputer is a computer that performs computations using biological components such as DNA, proteins, and cells. Instead of standard computers, Biocomputers modify and store information using biological processes rather than electronic components and silicon-based chips. Biocomputers can do complicated computations, such as pattern recognition and data processing, with far higher efficiency and accuracy than standard computers. The Biological Computer Is an implanted device used primarily to monitor the body's activities or to induce therapeutic effects at the molecular or cellular level. Biocomputers work similarly to ordinary computers, with the CPU serving as the brain and DNA as the software. When applying the questionnaire prepared for teaching biocomputers as one of the most important applications of artificial intelligence 'AI' in the biology course at the secondary stages in Egypt, the results we obtained showed the interest of students (both boys and girls) in these sciences. With similar statistical results between them (as a statistically non-significant difference $P < 0.05$). This confirms the importance of the trend of those preparing curricula to integrate these modern and future sciences into Egyptian schools.

Key Words:

AI, Biocomputer, Secondary School, Biology-Curriculum

1. Introduction:

The goals:

First aim, what is a Biocomputer in the concept of artificial intelligence?

The second aim is the difference between the traditional computer and the bio one.

The third aim, from the different aspects, is its structure, the idea of its working, and its different uses in the biological scopes.

The Fourth aim is to apply a questionnaire about integrating one of the modern topics in artificial intelligence 'AI', "biocomputers," to high school students to determine the extent of male and female student's responses and psychological and intellectual readiness to accept this research project as a proactive step.

The most recent and advanced disciplines of biology research are focused on using computing programs such as bioinformatics, biocomputing, and molecular view structure to gain more information, analysis, and new patterns in results. Artificial intelligence (AI) is a field of computer science that seeks to develop systems capable of intelligent behaviour. In essence, AI is about creating machines that can think, learn, and adapt. Here's a concise definition in ten lines: AI refers to the simulation of human intellect in machines. It allows machines to execute activities that normally need human cognition. This encompasses problem-solving, learning, planning, and language comprehension. AI systems are powered by algorithms, which make judgments based on patterns and inferences. Machine Learning, a branch of AI, employs statistical approaches to help machines improve with experience. AI applications include voice assistants and self-driving cars. It is revolutionizing industries by enabling unprecedented levels of efficiency and customization. Ethical concerns are critical as AI grows increasingly interwoven into society. The goal of AI research is to develop General AI capable of solving a variety of issues.

AI is still advancing, with possible implications for jobs, privacy, and security. AI is more than just a futuristic concept; it is already present in our daily lives, from search engines to tailored suggestions on streaming services. As technology advances, AI's capabilities will expand, influencing the future of many sectors. Leonard M. Adleman pioneered biocomputers in 1994, which use biological materials like DNA and proteins to store and process information (Benenson, 2012). These devices are remarkably efficient, using less than 1% of the energy required by electronic transistors (G. Paun, 1998). Researchers such as Thudi et al. (2012) and Kolay et al. (2021) envision bio-inspired algorithms being used for applications ranging from efficient data storage to complicated issue solving. Biocomputers, defined as systems that emulate electronic functions using biomolecules, replace standard silicon-based components with biomolecule-specific properties, achieving memory and logic processing like conventional computing systems (Thudi et al., 2012; Kolay et al., 2021). Furthermore, bio-computers, such as implantable devices, monitor body activity and can create therapeutic effects at the molecular or cellular level. The predictability of DNA hybridization chemistry, as demonstrated by Cheema, enables exact control over oligonucleotide length and content, making nucleic acids appealing for nanoscale applications. Bio-computers perform similarly to powerful computers, with DNA serving as the brain and CPU (Ismail, 2022). DNA computing, a type of technology that employs DNA, biochemistry, and molecular biology, has replaced traditional silicon-based technologies. Notably, a single pound of DNA produces more processing power than all computers ever manufactured, demonstrating the amazing lightweight nature of DNA computing. These systems excel at quickly solving complicated problems while using minimum power to prevent DNA denaturation (Ismail. M. A.,2022). In 1994, A. Arkin et al. Emphasized the dominance of silicon-based computers in technological domains. The cornerstone of modern computing is based on Boolean logic processes, in which binary digits represent "true" as "1" and "false" as "0," as articulated by N.C.J. Seeman in 1982.However, the persistent pursuit of downsizing and increasing processing needs have revealed limitations in silicon's capacity. In response, researchers led by C.Y. Zhou et al. in 2018 investigated alternate biomolecules for logical processes, with the goal of addressing complicated issues beyond the capabilities of typical silicon-based computers. To address these issues, a variety of bottom-up initiatives have been implemented. Notably, I. Amlani et al. (1999) provided successful demonstrations, including Turing machine simulations. This study into new paths has the prospect of solving complex challenges that are beyond the capacity of traditional silicon-based systems. Bioelectronics is an interdisciplinary study topic that uses biomolecules to demonstrate or implement electronic functionality on chips (Willner, 2001; Zhang et al., 2016). Bioelectronics is being recognized as having the potential to overcome the current limitations of conventional silicon-based devices, including critical physical limitations such as the thickness limitation of silicon-based circuits and the occurrence of errors or malfunctions due to increased circuit integration, or to suggest a new direction for the electronics field (Bostick et al., 2018).To date, numerous bioelectronics devices have been produced, including bio-memory and biologic gates (Choi et al., 2007; Sun et al., 2019). Carbon nanomaterials have sparked great interest in the biological field, particularly bioelectronics, due to their exceptional mechanical capabilities and conductivity resulting from their unique architectures (Cho et al., 2020).

The ultimate goal of merging molecular biology and engineering is to create a biocomputer (Wang B. Et al., 2011; Miyamoto T. Et al., 2012; Xie Z. Et al., 2011).To do this, a vital module known as the control unit (CU) should be present to command a variety of logic or arithmetic processes within the CPU (Choutko, et al., 2007).It directs the computer's memory, arithmetic/logic unit (ALU), and input/output devices to respond to macro instructions by organizing timing and control signals. (Lin C-L et al. 2015). A biological circuit differs from a digital logic circuit in that it uses chemical reactions of gene expression to simulate on and off states of protein concentration with DNA-binding proteins and DNA-binding factors expressing protein concentration for a specific logical function (Wong A. Et al., 2015; Marchisio, MA. & Stelling, J., 2011). With the rapid advancement of synthetic biology, a class of combinational and sequential genetic logic circuits have emerged for specialized purposes (Chuang C-H, et al., 2013; Lauria M, et al., 2004).

DNAzymes are employed in DNA computing, which is fundamentally comparable to parallel computing in that it takes advantage of many separate DNA molecules to test many different possibilities at the same time (Ismail. M. A., 2022). These DNAzymes are utilized to construct logic gates similar to digital logic in silicon; however, DNAzymes are confined to one, two, and three input gates (Ismail. M.A., 2022). At its most fundamental, a computer is a collection of powered and unpowered circuits and transistors (Ismail, M.A., 2022). A logic gate is a set of transistors coupled together to produce one or more outputs, each of which is dependent on the input or combination of inputs supplied to it (Ismail, M.A., 2022). The transistor is a semiconductor device with three connections that can amplify as well as rectify (Ismail, M.A., 2022). In the digital realm, a transistor is a binary switch that serves as the fundamental building block of computer circuitry. A single modern CPU may have hundreds of millions or perhaps billions of transistors (Ismail, M.A., 2022). AI, or Artificial Intelligence, is a field of computer science that focuses on developing intelligent machines capable of executing activities that would normally need human intelligence. These tasks include comprehending normal language, identifying visuals, making judgments, and learning via experience. AI is made feasible by the creation of algorithms and models that allow machines to process and analyze enormous volumes of data, discover patterns, and anticipate outcomes.

3. Methods of Research and the tools used:

Material and Methods

According to Bhandari and Nikolopoulou (2020), the Likert scale a rating scale used to measure opinions, attitudes, or behaviours. Moreover, it consists of a statement or a question, followed by a series of five or seven answer statements. Respondents choose the option that best corresponds with how they feel about the statement or question.

In practical application, the format of a typical fore-level Likert question, for example, could be:

١. Strongly disagree

٢. Disagree

٣. Agree

4. Strongly agree

Graduation Project " مشروع التخرج"

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A questionnaire on the study of "biocomputers" as one of the applications of artificial intelligence (AI) in secondary school curricula in Egypt

"استبيان لطلبة مدرسة السباحين الثانوية التجريبية لغات بإدارة السيد زينب"

حول دراسة "الكمبيوتر الحيوي" كأحد تطبيقات الذكاء الاصطناعي (AI) في مناهج المرحلة الثانوية في مصر

Supervised by:

***Asst. Prof.* / Mohamed A. Ismail**

Asst. Prof. of Molecular Cell Biology

Put only one check mark (✓) in front of your opinion on each point:

Subjects of the discussion	Opinions and tendencies about discussion			
	Strongly agree	Agree	Disagree	Strongly disagree
1. I have heard about artificial intelligence (AI) before.				
2. The study of (AI) is considered an unimportant subject in developing countries such as Egypt.				
3. In the educational process, it is preferable to rely only on memorization without resorting to these difficult topics, such as (AI).				
4. I hope that the biology course includes the study of (AI), especially biocomputers.				
5. The availability of the necessary resources, tools and means to study biocomputers is important in the coming era.				
6. If you know that the working mechanism of DNA and proteins has an important role in the invention of the biocomputer, our interest in studying molecular biology and bioinformatics will increase.				
7. The integration of AI and biocomputers contributes to advancements in healthcare or other industries.				
8. I am interested in knowing the challenges facing the development and implementation of biocomputer technology.				
9. The ethical considerations surrounding the use of biocomputers are so important.				
10. The future of biocomputing looks like a milestone for potential inventions.				

"Thank you for participating with us in this questionnaire".

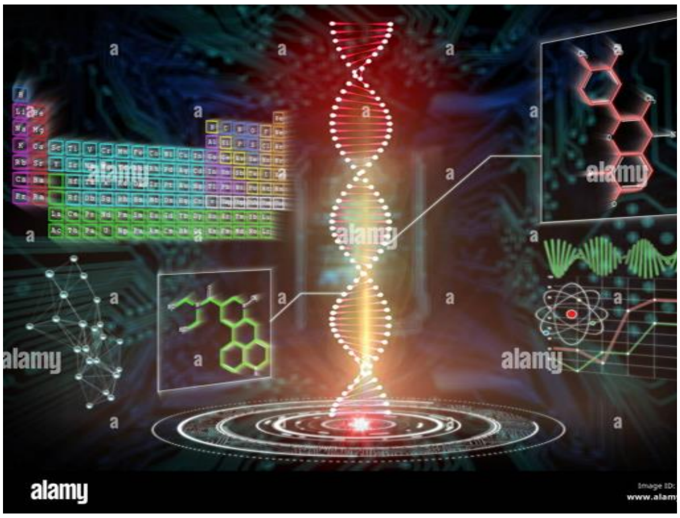
Performance over time without being explicitly programmed. Artificial intelligence has applications in a variety of areas, including healthcare, banking, manufacturing, and entertainment. It is used to improve medical diagnosis, automate financial transactions, streamline manufacturing operations, and customize user experiences. However, AI raises worries about privacy, bias, and the influence on job.

Biocomputers use biomaterials such as DNA, proteins, and enzymes to process information. Adleman's famous 1994 study revealed the use of DNA strands for computational problem solving. Tamsir et al. Investigated modified proteins to create logic gates within cells in protein-based computing. Green et al.'s 2017 study looks into RNA molecules that execute computing in living cells, highlighting possible applications in synthetic biology. Katz and Privman's 2017 study sheds insight on enzyme-based systems, which employ enzymes as components in biocomputers. Wang et al.'s 2013 work demonstrates the application of synthetic biology approaches to design cells for specific computing purposes Zhang et al.'s 2019 study on biosensors and bioelectronics for portable biochemical detection exemplifies the exploration of hybrid systems that combine electrical and biological components.

They highlight the practical uses of combining biological materials and electrical interfaces. Quantum dots have received attention for biocompatible computing, as evidenced by Alipour et al.'s 2018 work on Quantum Dot Cellular Automata. Graphene's nanoscale characteristics are being investigated, with Wang et al. Discussing their applications in bioimaging and related domains in 2018. DNA origami, as described by Zheng et al. In 2018, offers fascinating prospects for biocomputing, notably precise drug targeting via folded DNA Nano devices.

Sarparanta et al. "Cyborg Cells: Functionalization of Living Cells with Polymers and Nanomaterials" (2018) investigates the integration of live cells and electronic components, providing insights into the development of bio-hybrid systems for improved computation.

"Peptide Nucleic Acid Functionalized Graphene Oxide for Cellular Imaging and Drug Delivery" (2018) in the work of Chen et al. Investigates nanomaterials for biocomputing, demonstrating the utility of peptide nucleic acid-functionalized graphene oxide in cellular imaging and medication delivery. Additionally, Li and Lin's "Biorthogonal Chemistry for Site-Specific Labelling and Surface Functionalization of Nanomaterials" (2019) investigates biorthogonal chemistry techniques for precisely labelling and functionalizing nanomaterials, laying the groundwork for advanced bio-integrated computing systems.



“Nanomaterials for Neural Interfaces” (Luo et al., 2021). Investigates the use of nanomaterials to create interfaces with brain systems, highlighting the possibility for biocompatible neural computing. Furthermore, Chen et al. Published “DNA-Based Computing: A Survey and New Perspectives” (2020). Provides a thorough review of DNA-based computing techniques, including the utilization of DNA strands for data processing and calculation.

Wang et al. Published a paper titled “Nano electronic Programmable Synapses Based on Phase Change Materials for Brain-Inspired Computing” in 2019.

Delves into the use of nanoelectronic devices, specifically phase change materials, in brain-inspired computing. Lee et al.’s “Biocompatible and Bio-Inspired Materials for Neural Interface Engineering” (2020) sheds light on the creation of neural interface-appropriate materials, setting the framework for bio-inspired computing systems. Pierrat et al. “Living Bioelectronics: Strategies for Developing Smart, Sustainable, and Self-Sufficient Implants” (2021) examines the incorporation of biological elements into computing. It discusses approaches to creating bioelectronic devices that can use living organisms for intelligent, sustainable, and self-sufficient implants.

Sundstrom and Olofsson’s “Biohybrid Systems for Metabolic Engineering and Biocomputing” (2021) also investigates the convergence of synthetic biology and materials science to build biohybrid systems for metabolic engineering and biocomputing applications.

A biocomputer is a computer that performs computations using biological components such as DNA, proteins, and cells. Biocomputers, as opposed to standard computers, modify and store information using biological processes rather than electronic components and silicon-based chips. Biocomputers have the capacity to do complicated computations, such as pattern recognition and data processing, with far higher efficiency and accuracy than standard computers. They also have the advantage of being able to operate in situations where electronic devices would be impractical, such as inside the human body. Biocomputing research is still in its early phases, but it has the potential to revolutionize fields such as health, environmental monitoring, and artificial intelligence.

Medical Applications: Bio computers and organoid intelligence have the potential to transform medicine by allowing for the development of tailored treatments and improved drug discovery. These technologies could also be utilized to develop implantable devices that can monitor and control biological activities in real time.

Environmental Monitoring: Biocomputers and organoid intelligence can be used to identify pollution in air and water. This could help us build more effective environmental and health protection initiatives.

Robotics: Biocomputers and organoid intelligence could be combined to create intelligent robotic systems capable of performing complicated tasks with improved accuracy and efficiency. These technologies could be employed in a variety of settings, including manufacturing, agriculture, and space exploration.

Artificial Intelligence: Biocomputers and organoid intelligence could be utilized to create new types of artificial intelligence that are more efficient and adaptive than conventional computing systems.

Disease modelling: Biocomputers and organoids can be used to simulate complicated diseases like cancer, Alzheimer's, and Parkinson's. Certain models can help researchers better understand how certain diseases evolve and find potential new treatments.

Biochemical computers, also known as chemical computers, perform computations using biochemical reactions and processes, exploiting molecules' chemical features and interactions to modify information. Several methods have been investigated in this field:

Enzymatic computing uses enzymes to do calculations by constructing reaction networks and pathways, with enzymes acting as logic gates or executing molecular.

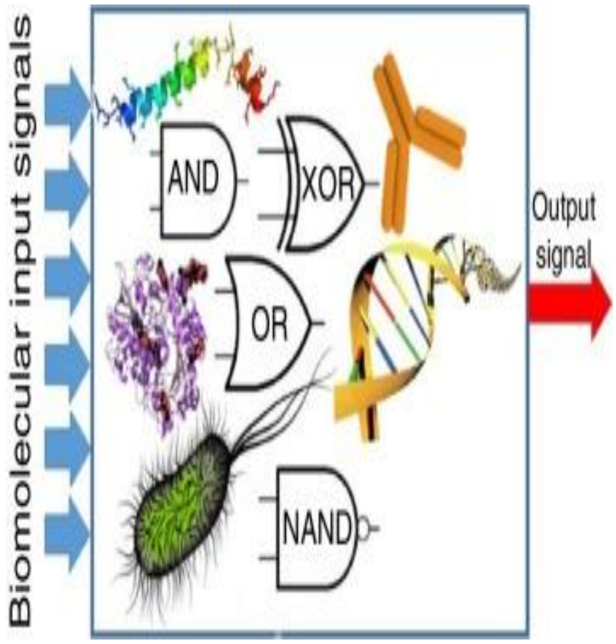
arithmetic operations (Adamatzky, 2016). Chemical reaction networks, which are made up of interconnected processes, can execute calculations based on chemical species concentrations and interactions, employing ideas from reaction network theory and chemical kinetics (Soloveichik et al. 2010). Molecular computing makes use of individual molecules or molecular assemblies, such as DNA strands, as information carriers or processors, creating molecular logic gates, switches, and circuits for specialized computational tasks (de Silva & Uchiyama, 2007). Self-assembly and self-organization use the spontaneous organization of molecules into ordered structures or patterns for computational purposes, which is accomplished by manipulating the properties and interactions of molecules (Sayama, 2015).

Biomechanical computers, which are computational systems that incorporate biological components or principles, are still in the early phases of development, with numerous ways proposed. Here are a few methods under consideration.

DNA-based computing uses DNA strands to encode and modify information via biochemical reactions, providing huge parallel computation capability due to DNA's inherent characteristics (Adleman, 1994). Protein-based computing makes use of proteins' unique features and interactions for computations, such as protein folding to represent binary information (Lakin et al., 2012). Cellular automata principles use living cells as computational units, with possible applications in engineered bacterial colonies or cellular networks for computation (Adamatzky 2010). Neuronal networks, inspired by the brain's neural networks, use biological neurons or neuron-like components to perform calculations, leveraging parallel processing and adaptability (Indiveri et al., 2013).

Bioelectronics computers combine electrical components with biological materials or principles in order to use biological system features for information processing. Various strategies have been investigated: Organic electronics uses organic materials such as conductive polymers to create biocompatible interfaces in bioelectronic devices (Malliaras & Rivnay, 2018). Neural interfaces, which use techniques such as implantable electrodes, allow information to be exchanged between electronic devices and neural systems (Nicolelis, 2011).

Neuromorphic circuits are an example of bio-inspired circuits, which replicate the structure and dynamics of biological systems to conduct calculations. Biofuel cells transform chemical energy from biological fuels into electrical energy, providing a sustainable power source for bioelectronics systems (Katz & Willner, 2004).



Biocomputer engineering is creating computational systems that use biological components such as DNA, proteins, cells, or other biological materials for computation. Several techniques have been used in this field: DNA-based biocomputing makes use of the features of DNA molecules, such as sequence complementarity, to do calculations, using techniques such as DNA strand displacement processes and self-assembly for logic gates and algorithms (Seelig and Soloveichik, 2010). Synthetic biology approaches allow for the creation of genetic circuits with specialized computational behaviours, such as logic operations or complicated calculations within live cells (Khalil & Collins, 2010). Cellular computing uses collective cell behaviours in networks like bacterial colonies to achieve computation via cellular signalling pathways and communication (Tamsir et al. 2011).

Protein-based computing takes advantage of proteins' activities and interactions to create protein switches or logic gates for information processing (Moon et al., 2012).

4. Results of Research

Table : showing the opinions, tendencies, and trends of male and female students in secondary school, El Sabahain Experimental Language School, El Sayyida Zeinab ,Cairo.

Answer degree / Measured parameters	Strongly agree		Agree		Strongly disagree		Disagree	
Sex	Females	Males	Females	Males	Females	Males	Females	Males
Mean	9	8	5.8	8.4	2.9	1.2	3.3	2.8
±SD	±6.5	±5	±4.1	±2.8	±3.7	±2.2	±3.3	±3
Mean of Total No. (±SD)	**Males: 5.1 (±3.6)** **Females: 5.25 (±2.8)**							
****P***	*** Statistically non-Significant Difference *P* > 0.05**							

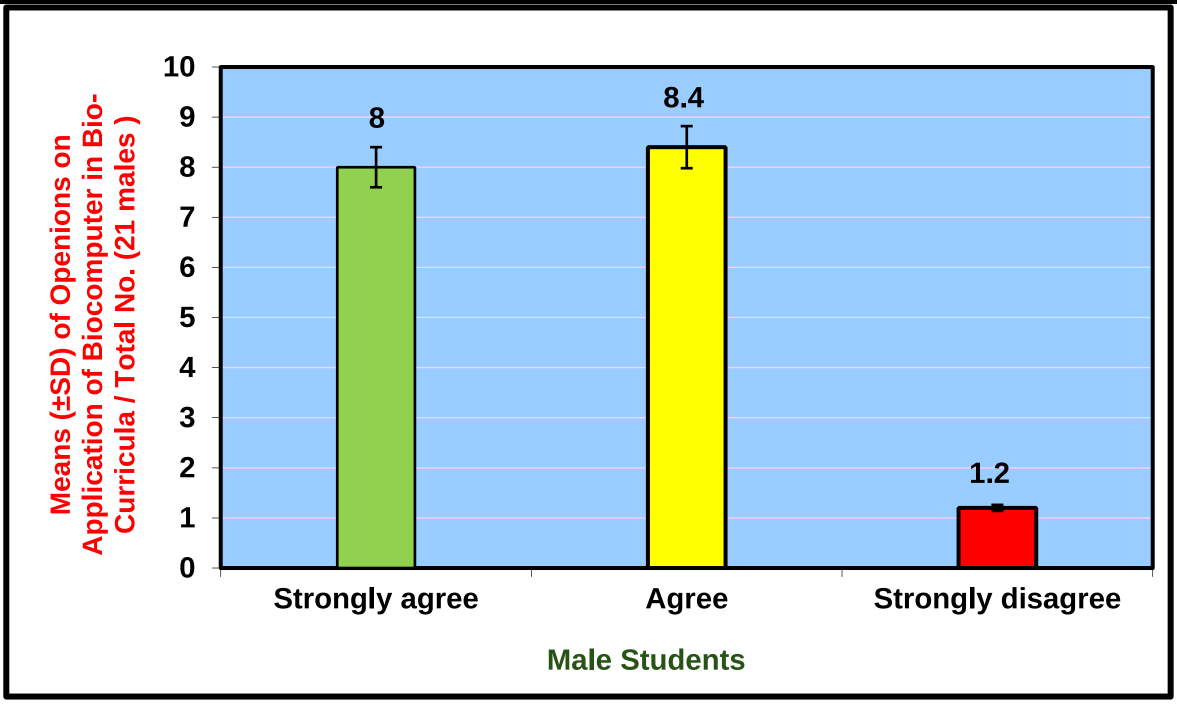


Fig. (1): Histogram of opinions of male students to questions on the study of "biocomputers" as one of the applications of artificial intelligence (AI) , as designed by Likert scales to measure their attitude on application of Biocomputer in their Bio-Curricula.

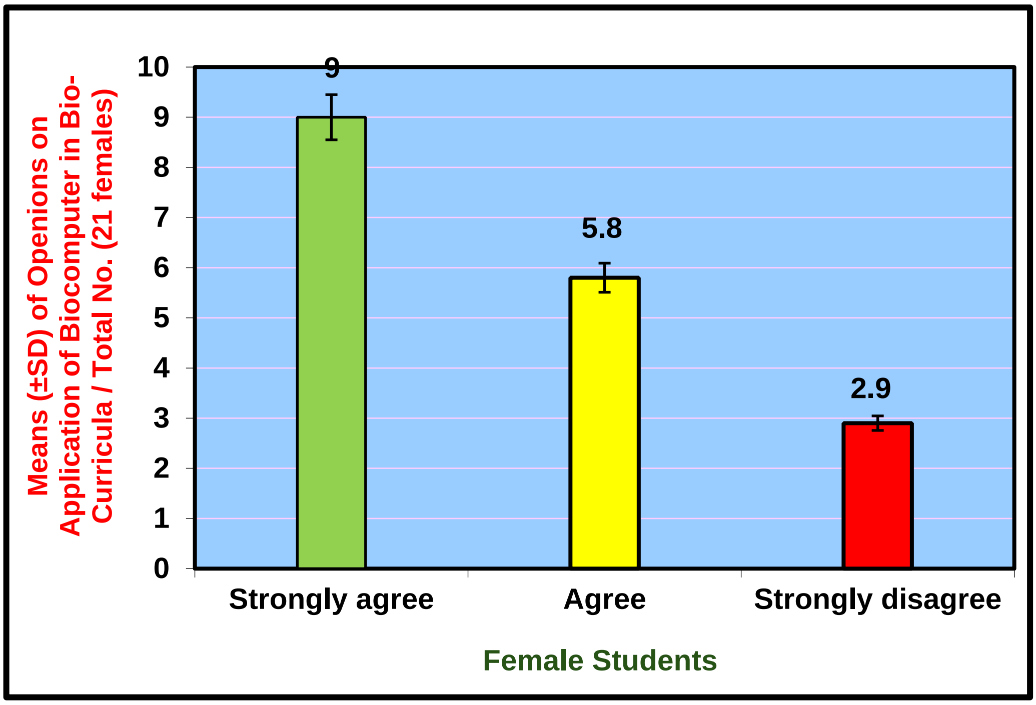


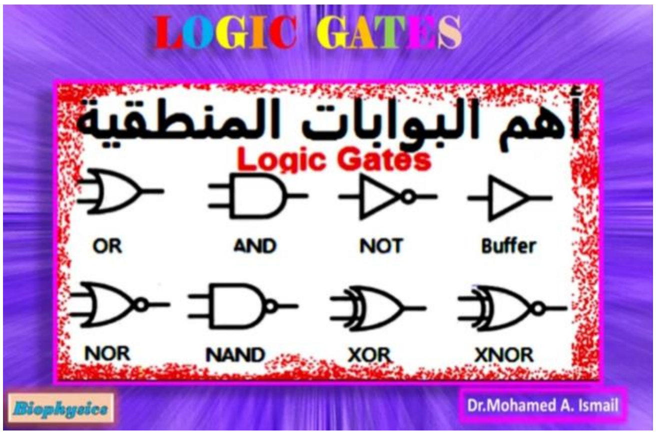
Fig. (2): Histogram of opinions of female students to the questions on the study of "biocomputers" as one of the applications of artificial intelligence (AI) , as designed by Likert scales to measure their attitude on application of Biocomputer in their Bio-Curricula.

5. Interpretation of Results

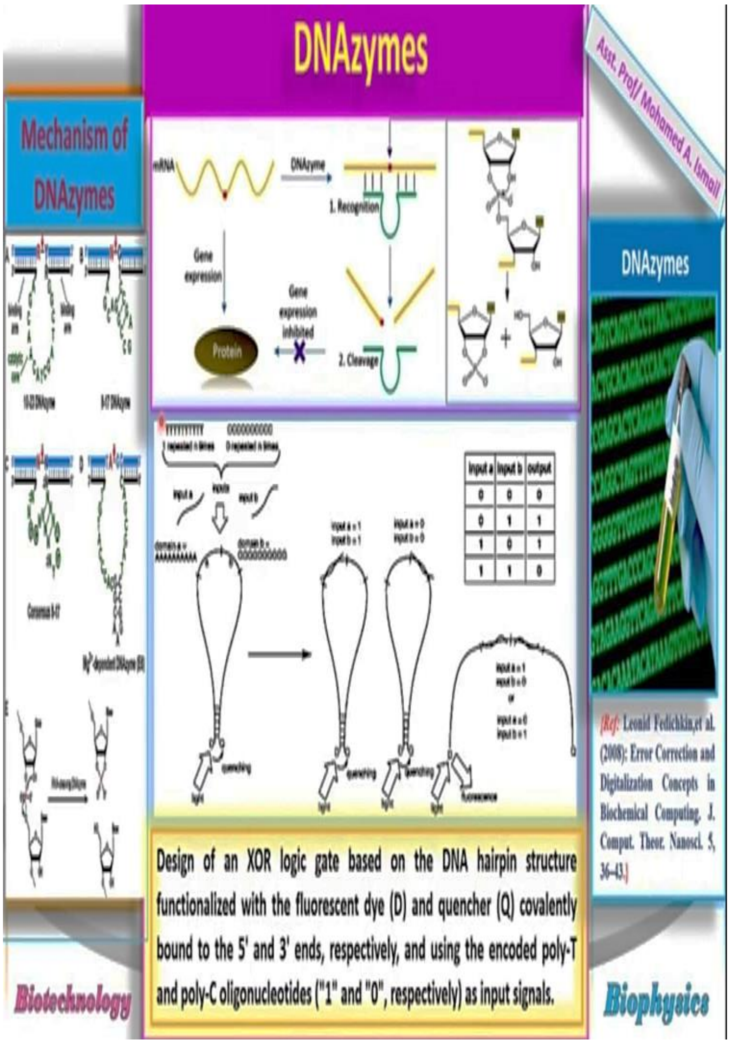
P is higher than 0.005 This means that there is no difference between the opinion of males and females on this topic.

It is fantastic that you ran a questionnaire on the research of biocomputers and their incorporation into secondary school curricula in Egypt. The fact that the standard deviation is non-significant shows that there is little variety in the students' responses. This could imply a level of agreement or consistency in their thoughts or knowledge of the subject. We have presented a brief overview of the growing molecular and biological computation topic primary processor, sometimes referred to as the central processing unit (CPU), oversees carrying out computer program instructions. We concluded from the questionary results that the number of students (male and female)who strongly agree the subject were somewhat close in number and they constituted the largest percentage, while the number of students who disagree the subject was small. As for the total average, the number of students was very close, indicating that the minds of girls and boys are quite like a large extent about that topic.

Biocomputers, on the other hand, use biological components like DNA molecules rather than conventional electrical parts to provide mathematical capabilities equivalent to those of a high school classroom. Combining computer science, biology, and engineering, biocomputing uses biological molecules like DNA for computational operations. Similar to conventional computers, bio-computers operate by using DNA as the software and the CPU as the brain. Artificial DNA-based live microprocessors are the wave of the future for biocomputers. While silicon-based technologies use semiconducting silicon material for electronic circuits, DNA computing uses DNA for computation. In parallel computing, several processors carry out smaller tasks concurrently. Parallel processing, lightweight design, low power consumption, speedy problem resolution, and medical applications are just a few of the advantages of biological computers. Biocomputers are used for a variety of reasons, including multiprocessing capability, energy efficiency, little waste, self-recovery, vast memory capacity, and the possibility for artificial intelligence. Despite past dependability concerns and restricted transmission capability, biocomputers show promise in numerous domains such as diagnosis, therapy, and medical engineering by integrating biotechnology, genetic engineering, and medical sciences. DNAzymes, which are used in N Compu, work in a similar way as parallel computing by using multiple DNA molecules to investigate multiple possibilities simultaneously. These DNAzymes build logic gates like digital logic in silicon, however limited to one, two, and three input gates. A computer is made up of powered and unpowered circuits and transistors, including logic gates—series of interconnected transistors—that produce outputs based on input combinations. Transistors, which are semiconductor devices with three connections, act as binary switches in the digital realm and play an important role in computer circuits, with modern CPUs including billions. Logic gates, the essential components of digital integrated circuits, perform basic logical processes, typically accepting two binary inputs and producing a single output. They include many sorts like as AND, OR, and NOT gates, which constitute the foundation of computer hardware.



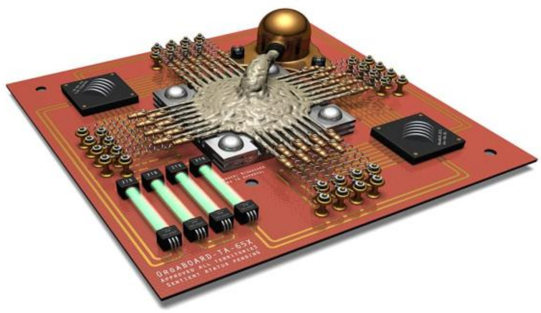
A DNAzyme is a short strand of DNA used to cut RNA, similar to an endoribonuclease, which efficiently cleaves specific RNA molecules. These DNA-based enzymes are exceedingly stable and inexpensive to generate, indicating potential for commercial applications. They are used to build bio-logic gates that resemble digital logic in silicon, but only have one, two, and three inputs. When a DNAzyme logic gate attaches to a matching oligonucleotide and a fluorogenic substrate, its structure changes, allowing fluorescence measurement to identify reaction occurrence. As a result, the used DNAzyme cannot trigger additional reactions, necessitating its deployment in devices such continuous stirred tank reactors for renewal. Notably, Caltech researchers created a circuit using 130 single DNA strands capable of computing the square root of numbers up to 15. One example is the construction of an XOR logic gate that uses a DNA hairpin structure functionalized with a fluorescent dye (D) and quencher (Q) coupled to the 5' and 3' ends, respectively. This gate takes encoded poly-T and poly-C oligonucleotides ("1" and "0" respectively) as input signals. The field is based on ideas and technologies established in the domains of synthetic biology and DNA- and RNA-based computing, respectively. However, this is a stand-alone undertaking because its philosophical forebears are far broader in scope (particularly synthetic biology, which encompasses almost everything related to the rational design of biological systems). Biocomputers are conceptually well-defined organisms whose practical implementation is challenging. The initial barrier of just the circuit is dedicated to ensuring resilient, stable operation. Resilient, stable operation. considering the options and developing appropriate queries is probably behind us. The field appears to have established several achievable aims as well as long-term aspirations. Soon, we must demonstrate that in vivo computations using transcriptional, post-transcriptional, and posttranslational networks, as well as combinations of these networks, can progress from proof-of-concept and simple circuits with a small number of elements to much more complex systems capable of solving real-world problems. There is also a need to clearly illustrate how in vivo computers will outperform competing technologies, and I believe that complexity will be crucial here.



Discussion:

Biological computers are microcomputers created specifically for medical applications. The biological computer is an implantable device that is primarily used to monitor the body's activity and induce therapeutic effects at the molecular or cellular level. This is composed of RNA, DNA, and proteins and can execute basic mathematical calculations.

This could allow the researcher to create an array or system of biosensors capable of detecting and targeting specific types of cells located in the patient's body. This could also be employed to carry out or perform target-specific medicinal operations that offer medical procedures or remedies as prescribed by the doctor (Jeevani T., 2011).



The primary advantage of this technology above other similar technologies is that it allows a clinician to focus on, locate, and treat specific damaged or sick cells. Selective cell therapy is now possible. Furthermore, the implantable biological computer is a device that could be employed in a variety of medical applications requiring intercellular evaluation and treatment. It is very beneficial for monitoring intercellular activity, including gene mutations (Ismail M.A., 2022). Biological computers are primarily used to monitor the body's activity and induce therapeutic effects at the molecular and cellular levels (Kurioka D., et al., 2011). A 'DNA computer' was utilized for the first time to locate the only correct answer from over a million alternative solutions to a computational issue (Blasiak J., et al, 2011). The researchers predict that the complexity of living molecules' structures will enable DNA computers to outperform their electrical equivalents in the future. The concept of DNA computing was first realized in 1994, when Adleman solved the Hamiltonian Path Problem with short DNA oligomers and DNA ligase. Biological computers are built within a patient's body. The sheer information about the patient's body is referred to as a blueprint along which the biological computer would be created (Buchko G.W., 2011).

Once the genetic blueprint for the computer is delivered, the human body will begin to develop it utilizing its inherent biological processes and cells (Ewing G.W. & Ewing E.N., 2009. The biological computer may be used to quickly identify all forms of cellular activity and assess whether or not a certain activity is detrimental by using Boolean logic equations (Sarvestani A.S., 2011). This technology's primary benefit over similar ones is that it allows a physician to target, identify, and treat only diseased or damaged cells (Ammer A.G., et al., 2009). The biological computer is capable of detecting all the gene activity in cells, including mutant genes, among other gene activities. The biological computer, like conventional computers, uses an output and an input signal. The biological computer's primary inputs are the body's proteins, RNA, and other unique molecules found in human cytoplasm (Shirotake S. Et al., 2009).In a parallel computing architecture, many processors work together to do smaller, more manageable calculations that are decomposed from a single, more difficult problem (Ismail M.A., 2022). Biological Computers' Benefits 1. Massive parallelism characterizes biological computers. Dividing a task into smaller parts and carrying out each part concurrently is known as parallel computing. 2. Exceptionally light: You own more computing capability than all previous computers combined with just one liter of DNA. 3. Low

Power: The only power required is to prevent denaturation of DNA. 4-Solves Complex Problems Quickly: According to Ismail M.A. (2022) a DNA computer can solve even the most difficult problems faster. Why is Biocomputer used by us? Advantages: 1. Multiple processors. 2. Minimal Energy Expense. 3. Minimal Waste. 4- Recovery of Oneself. 5-Huge Retention The sixth level of artificial intelligence (Al): 1. Parallel Computation: Everyone can work simultaneously! 2. Large Memory: Compared to 1000000000000 CDs, 1cm of DNA can hold a lot more info! Cons: 1. Untrustworthy thus far. 2. Incomprehensible (Ismail, M. A., 2022).

Biological computers, also known as mini brains, are 3D cultures of brain tissue and neurons that imitate the structure and functions of our brains. This technology will allow you to combine the computing power of the greatest computers with the energy efficiency of the human brain. In the future, "bio-computers" may provide important instruments for research, particularly in the study of specific disorders.

6. Conclusion

In conclusion, this technology will allow you to combine the computing power of the greatest computers with the energy efficiency of the human brain. In the future, "bio-computers" may provide important instruments for research, particularly in the study of specific disorders. Thus, all the research objectives have been met, which were as follows: First, define a bio-computer in the context of artificial intelligence. The second goal is to distinguish between a regular computer and a biological one. Third, consider its structure, operating principle, and many applications in biological contexts. The fourth goal is to administer a questionnaire to high school students about incorporating one of the modern topics in artificial intelligence 'AI', "biocomputers," to determine the extent of male and female students' response as well as their psychological and intellectual readiness to accept this research project as an early step.

7. Acknowledgement:

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