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Elements of RNA, its Techniques and Applications

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Introduction

RNA (Ribonucleic acid) is similar to DNA (Deoxyribonucleic acid). However, unlike DNA it is stable and move active member of nucleic acid family. Two major difference between RNA are 1) RNA differs from DNA by one nucleotide and 2) RNA consist of a single strand (one nucleotide) and not double helix. [1]

DNA and RNA are the most vital molecules in cell biology, responsible for storage and reading genetic information that is the base of all life. DNA encrypts all genetic information and is the prototype from which all biological life is created. RNA functions as the reader that decodes. There are three types of RNA 1) mRNA – copies fragments of genetic code, process called transcription, and transports to ribosomes, which are cellular factories that enables the production of proteins from this code. 2) tRNA – it is engaged for bringing amino acids, basic protein building blocks, to these protein factories, in response to the coded instructions received by mRNA. This protein building is called translation. 3) rRNA – is a component of the ribosome factory itself without which protein production cannot occur. [2]

Below are few techniques and applications from plenty of RNA applications.

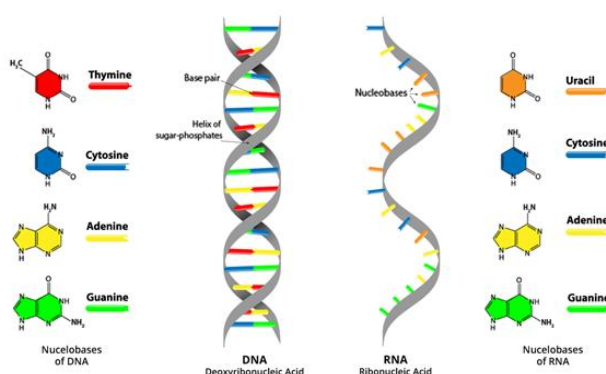


Fig. 1 Illustrates comparison of the Helix and Base Structure of RNA and DNA. Image Credit Ruairi J MacKenzie [2]

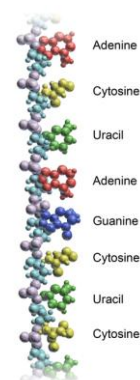


Fig. 2 Illustrates Nucleobases in an RNA molecule. Vijini Mallawaarachchi [Ref 1]

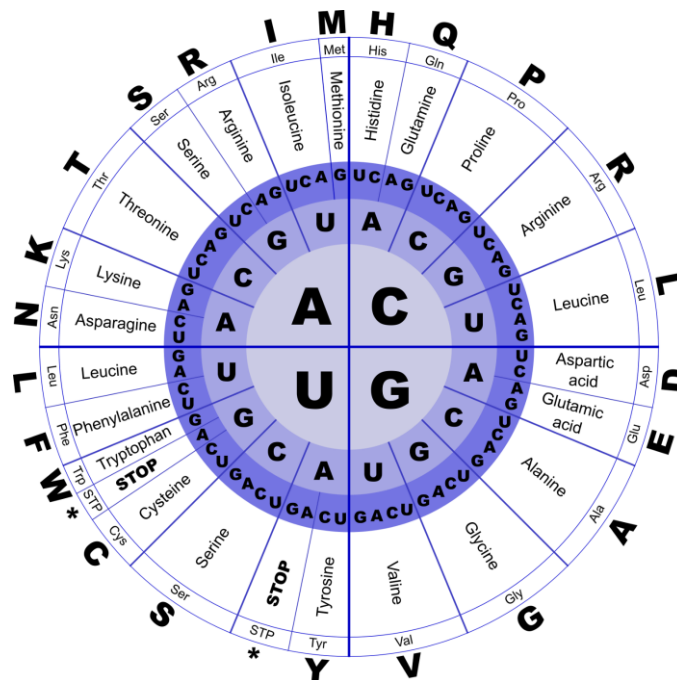


Fig. 3 Illustrates Genetic code chart for RNA. Image Credit Vijini Mallawaarachchi [Ref 1]

Transfer of Memory through RNA injection

Ribonucleic Acid (RNA) has been widely known as a cellular carrier that makes proteins and transports DNA's instructions to other parts of the cells. Therefore it is understood to have other vital functions addition to protein coding, including control of variety of cellular processes involved in development and disease. Scientists at University of California – Los Angeles (UCLA) extracted RNA from RNA from nervous systems of marine snails that received tail shocks the day after the second sequence of shocks, and also from marine snails that did not received any shocks. Then RNA was introduced into seven marine snails that did not received any shocks. Unusually, researchers found that the seven that received the RNA from snails that were given shocks behaved as if they themselves had received the tail shocks. They presented a defensive contraction that remained an average of about 40 seconds.

“If memories were stored at synapses, there is no way experiment would have worked” was said by Glanzman, who included that marine snail is an excellent model for studying the brain and memory. [3, 4]

Innate Immunity is unlocked by RNA Key

RNA has been long disregarded in biomolecules, the go-between DNA, which encrypts the cell's instructions and proteins which carry them out. Increasingly scientist are identifying RNA as a versatile molecule with possibly as many functions as proteins have. Graeme Conn who was

supervising the work studies on how RNA is involved in the body's responses to infections. When human cell gets awareness of virus, it activates a signaling pathways: a protein called OAS gets turned on and generates a signaling molecule, which in turn activates another protein that both directly defends against the virus as well as triggering other parts of the cell's innate immune systems. As it turns out, human RNA might play a vital role in pathway, particularly a human RNA molecule called nc886. The "nc" stands for "non coding", which means this RNA molecule is not transporting instructions for building protein. It's doing something all on its own. What it's doing is, is turning on OAS, thus setting off the chain of events that destroys viruses. Extending more into molecular details of cells first responses to viruses opens the door of new kind of treatments. Calderon contemplate that understanding the factors that activate this pathways may enable scientists and researchers to someday manipulate it to strengthen antiviral defenses.

"Such approaches have potential to build a base novel, broad antiviral therapies on acquired immunity and therefore are suitable for infants, elderly and immunocompromised patients" was said by Calderon. [5, 6]

Turning DNA and RNA ON – off

DNA and RNA are usually polarized fragments of molecules that hold electric dipole moments due to existence of significant number of charged atoms at neutral pH. Researchers consider that these molecules fragments have an in-built polarization that can be reoriented or reversed fully or in part under an electric field, referred as bio ferroelectricity. Nevertheless, the mechanisms of these properties remains uncertain. This research shows that all RNA and DNA building blocks, nucleobases, exhibit a non-zero polarization in the existence of polar atoms or molecules such as amidogen and carbonyl. They have two stable states, displaying RNA and DNA have memory properties similar like ferroelectric or ferromagnetic material. This is appropriate for finding better ways of storing information in RNA and DNA because they have high capacity for storage medium. Such physical properties may play a vital role in biological processes and functions. Particularly these properties could be very useful for possible applications as a biosensor to detect DNA damage and mutation.

In this impressive analysis; the minimum electric field required for exchanging the polarization of a nucleobase is inversely proportional to the ratio of the topological polar surface area (TPSA) to the total surface area (TSA) of a nucleobase. As a result, this assignment provides priceless insights for possible presence of ferroelectricity in biomaterials; further, switching mechanism and ferroelectric properties of RNA and DNA nucleobases could acknowledge future developments of DNA and RNA based nanomaterials and other electronic devices. [7, 8]

RNA circuits can transform cells into Nano devices

In this research, described circuits composed of Ribonucleic Acid. These circuit construction simulate classical electronic circuits, self-assemble in bacterial cells, recognizing them to sense incoming messages and respond to them by generating a specific computational output (in this case, a protein). In this new research, specific circuits known as logic gates were designed and then were

incorporated in the living cells. These microscopic circuits changes and stumbles when messages (RNA fragments) fasten themselves to their complementary RNA sequences in the cellular circuit, triggering the logic gate and generating desired output.

The results of this new research have critical connotation for intelligent drug design and smart drug transportation, green energy production, low-cost diagnostic techniques and even future development of Nano machines capable of hunting down cancer cells or switching off aberrant genes. “We are using very predictive and programmable RNA-RNA interactions to define what these circuits can do. That means we can use computer software to design RNA sequences that function the way we want them to in a cell. It makes design process a lot faster” was confirmed by Green. [9, 10]

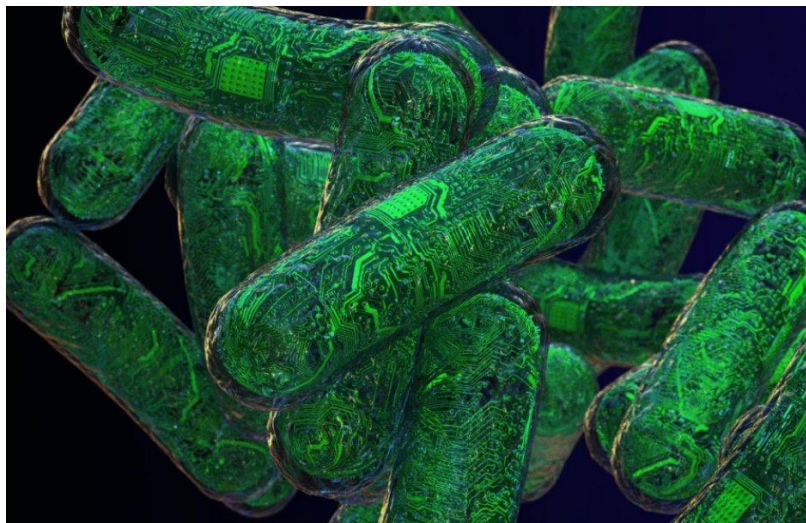


Fig. 4 Illustrates Ribonucleic acid (RNA) is used to create logic circuits capable of performing various computations. In new experiments, Green and his colleagues have incorporated RNA logic gates into living bacterial cells, which act like tiny computers. Image Credit: Graphic by Jason Drees for the Biodesign Institute [Ref 9]

Genetic disease can be corrected by novel RNA tool

RNA represents a diverse group of molecules within cells that behave like cells laborers, reading, regulating and expressing DNA's genetic instructions. RNAs are continuously in motion. They congregate, they carry out their work and they are broken up for recycling by RNA-degrading enzymes, which are chemical scissors that tear apart other molecules. About 2 percent of our genome encodes proteins and 70 to 80 percent of the genome is transcribed into RNA, potentially offering more targets. In this innovation tethers a drug like molecule – one engineered to bind precisely and selectively to a specific RNA – to common RNA degrading enzyme. The small molecule is designed to fasten onto the undesirable gene product and destroy it. This technology was titled as RIBOTAC, acronym for “ribonuclease-targeting chimeras” To test the RIBOTAC technique, Disney chose for his RNA degrading enzyme RNase L, which is a significant part of the human antiviral immune response. Present in small amounts in every cell, production of RNase L typically intensifies on viral infection to destroy the viral RNA and overcome the illness. For other part of the RIBOTAC complex, its

stimulant like fragment, researcher chose Targaprimir-96, a molecule engineered in lab to bind with a microRNA oncogene known to boost cancer cell proliferation, particularly in difficult to treat triple negative breast cancer, miRNA-96. [11, 12]

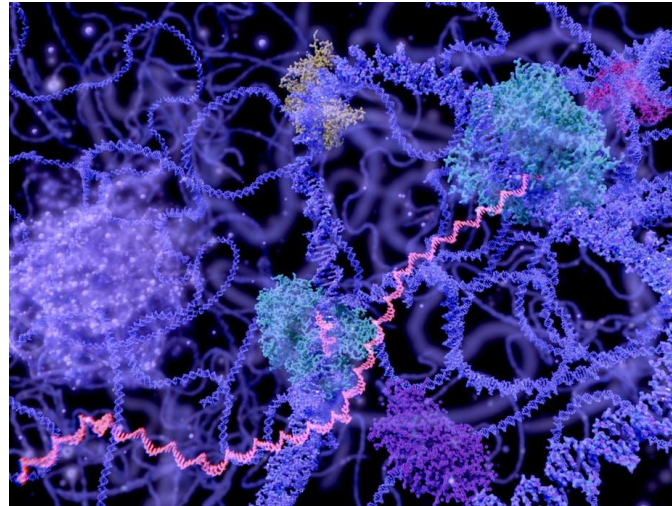


Fig. 5 Illustrates Cell nucleus with RNA [Ref 13]

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Conflicts of Interest

There are no conflict of interest as per Author's point of view.

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