

What is Ribonucleic Acid?

Posted on September 21, 2018

Ribonucleic Acid and the Biological Role of RNA Editing

RNA is known as Ribonucleic acid. RNA, similar to DNA, has significance in biology and biological mechanisms. The RNA structure and its use have been in the research setting where the scientist is trying to modify the structure of nucleic acid in the body to find the information and pathway to diagnose diseases. RNA editing is a process at a molecular level where some cells lead to a discrete change in the nucleotides.

The process of RNA editing results in RNA diversity and protein diversity in eukaryotes, which also have specific amino acids and proteins, leading to the creation, modification, and deletions of specific RNA sequences (Aman et al., 2018). In recent studies, RNA editing has been a trend in research and disease diagnosis. Rapid, inexpensive, and sensitive nucleic acid detection can help in the diagnosis of the disease, monitoring of the disease, and general laboratory tasks (Gootenberg et al., 2017). Research has concluded that the process of RNA editing can aid in the detection of genetic diseases. Several RNA editing processes are usually carried out by inserting or deleting the strands in the nucleotide. Editing is carried out on both plants and animals. The primary purpose of this paper is to understand the Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) and its related background for RNA editing.

Clustered Regularly Interspaced Short Palindromic Repeats is a process of nucleic editing and CRISPR/Cas13a class of type 2 ribonuclease (Gootenberg et al., 2017). The CRISPR editing process is carried out in plants and mammals. CRISPR aims to target the single-stranded RNA molecules of the genome phage, and CRISPR was previously known as C2c2 (Gootenberg et al., 2017). CRISPR-Cas 13 is basically a protein that helps in cutting RNA. The process is that Cas13 is able to find a specific sequence of RNA with the help of an RNA-guided molecule. Guided RNA is a programmable string of nucleotides for 30 bases. To elaborate on the process, CRISPR works in a way that abolishes the strands of RNAs that are toxic in nature and thus, in return, reverses the negative effects of the diseases on the body or the system (Knott et al., 2017). CRISPR generally uses the guided protein, Cas13 in this case, to identify the toxic strand of the RNAs, cut the desired set, and eliminate the muted gene expression (Cox et al., 2017). The Cas13 modification is carried out to cut the defective part and join the RNA.

CRISPR-Cas13, Molecular Diagnosis, and Therapeutic Potential

Studies have shown that CRISPR is effective in turning diseased cells into healthy ones, and the process can be used to treat several genetic diseases that are the result of muted genes or toxic RNA expressions (Gootenberg et al., 2017). CRISPR-Cas13a systems have the potential for RNA programmed and RNA detection and development of the designing of the RNA-binding proteins. The system has two main classes, and class 1 is multi-effector complexes that mediate the interference. Whereas class 2 is a single but multidomain effector for the mediation of the interferences. The system acts as a catalyst for the maturation of the transcribed precursor crRNA, and the crRNA is an active site that is metal-independent (Abudayyeh et al., 2017). The solution is not long-lasting because the RNA regenerates at a faster level, and the cell will regenerate to its original shape in a few weeks.

Type VI of the CRISPR-Cas has several elements, such as the base of Cas13a Enzyme, an RNA-activated Rnase that is capable of crRNA processing, and lastly, the single-stranded RNA degradation (Knott et al., 2017). The degradation of the binding of the target transcription. The CRISPR/Cas immunity has resistance to the invasion of phages and a conjugative plasmid in the archaea and bacteria. The mechanism has three steps, and the first step is the adaptation. In the adaptation, the spacers are taken from the invader genome. The second phase is the processing phase of the CRISPR RNAs, and the last phase is the molecular phase in which interference occurs against the invader genome (Knott et al., 2017). Several detection mechanisms are used for Cas13a RNA editing. A detection platform for Cas13a-based molecular detection is known as SHERLOCK. SHERLOCK stands for Specific High Sensitivity Enzymatic Reporter UnLOCKing, and the method is used to detect DNA & RNA for the diagnosis of diseases and other genetic disorders as well as for sensitive genotyping of the elements (Gootenberg et al., 2017).

The diagnostic tool, SHERLOCK, is a rapid, economical, and sensitive tool that has the power to see the result with the naked eye. SHERLOCK is useful in applications such as multiplexed RNA expressions and nucleic acid contamination detection. The SHERLOCK platform is used to detect strains and viruses, detect human DNA, and identify cell-free tumors and DNA mutations (Gootenberg et al., 2017). The tool has the sensitivity and power to detect nucleic acid material such as defective RNA strands, gene mutations, and other elements. The tool has the capacity to be used in healthcare issues and capacities. For example, the results from Gootenberg et al. in the year 2017 concluded that SHERLOCK can detect specific strains of Zika and Dengue viruses and make a distinction between various bacterial pathogens. It was also reported that SHERLOCK can determine the low-frequency cell-free tumor mutations in the DNA.

RNA Engineering and the Future of Genetic Medicine

Another function of RNA editing is the engineering of the mammalian cells for RNA knockdown and binding. *Leptotrichia wades* (LwaCas13a) is an effective mechanism for the interference assay in the *E. coli* and the heterogeneous expression of LwaCas13a in mammals and plants for the targeted knockdown (Abudayyeh et al., 2017). LwaCas13a is programmed with the guided RNA to edit the RNA sequence as well as bind the transcription in the mammalian cells. In other words, LwaCas13a knockdown is as efficient as RNAi, but the targets are off, which makes LwaCas13a a suitable option for therapeutic activities (Abudayyeh et al., 2017).

To conclude, RNA editing is a molecular process and can be used in the detection and diagnosis of diseases especially genetic diseases. One of the well-known processes of RNA editing is CRISPR, which is carried out in both animals and plants. Studies have concluded that CRISPR is one of the most effective methods of RNA editing and the detection of toxic strands of RNA. In the process, Cas13 is used as a guided protein to find toxic strands of RNA and cut out or eliminate the gene expression from that particular strand. There are different diagnostic tools or platforms available, such as SHERLOCK, and these assist the editing process.

References

- Abudayyeh, O. O., Gootenberg, J. S., Essletzbichler, P., Han, S., Joung, J., Belanto, J. J., ... Regev, A. (2017). RNA targeting with CRISPR-Cas13. *Nature*, 550(7675), 280.
- Aman, R., Ali, Z., Butt, H., Mahas, A., Aljedaani, F., Khan, M. Z., ... Mahfouz, M. (2018). RNA virus interference via CRISPR/Cas13a system in plants. *Genome Biology*, 19(1), 1.
- Cox, D. B., Gootenberg, J. S., Abudayyeh, O. O., Franklin, B., Kellner, M. J., Joung, J., & Zhang, F. (2017). RNA editing with CRISPR-Cas13. *Science*, 358(6366), 1019-1027.
- Gootenberg, J. S., Abudayyeh, O. O., Lee, J. W., Essletzbichler, P., Dy, A. J., Joung, J., ... Freije, C. A. (2017). Nucleic acid detection with CRISPR-Cas13a/C2c2. *Science*, eaam9321.
- Knott, G. J., East-Seletsky, A., Cofsky, J. C., Holton, J. M., Charles, E., O'Connell, M. R., & Doudna, J. A. (2017). Guide-bound structures of an RNA-targeting A-cleaving CRISPR-Cas13a enzyme. *Nature Structural and Molecular Biology*, 24(10), 825.