



# RNA Editing

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## Why in News?

Recently, **Wave Life Sciences**, a **biotechnology company** in the US, became the **first company** to treat a **genetic condition** by **editing Ribonucleic acid (RNA)** at the clinical level.

## What are the Key Facts About RNA Editing?

- **About:** RNA editing is the process of modifying **Messenger RNA (mRNA) nucleotides**, after **Deoxyribonucleic acid (DNA)** creates mRNA but before it begins **protein synthesis**.
  - mRNA is made up of portions called **exons and introns**. **Exons** eventually code for a **protein** whereas the **introns** are **non-coding parts** and are **removed** from the RNA before it's used to make a protein.
- **Types:** There are three types of RNA modifications i.e., **addition, deletion, and substitution**.
  - **Addition** is when a **nucleotide is inserted**. **Deletion** is when one is removed while **substitution** refers to the replacement of one nucleotide with another.
- **Mechanism:** The technique involves a group of enzymes called **adenosine deaminase acting on RNA (ADAR)**.
  - Scientists pair **ADAR's effects with a guide RNA (or gRNA)** that guides ADAR to a specific part of the **mRNA**, where the ADAR does the **designated job**.
- **Clinical Use:** Wave Life Sciences used RNA editing to treat  **$\alpha$ -1 antitrypsin deficiency (AATD)**, an **inherited disorder** through a therapy dubbed as **WVE-006**.
  - RNA editing shows **promise** for treating **Huntington's disease, Duchenne muscular dystrophy, obesity, Parkinson's disease**, neurological conditions, heart diseases, and more.

## Note:

- Challenges persist due to its temporary nature requiring **repeated treatments, current delivery systems**, such as **lipid nanoparticles** and **adeno-associated virus (AAV)** vectors, face limitations in accommodating large molecules.

## Ribonucleic acid (RNA)

- **Definition and Structure:** RNA is a nucleic acid present in **all living cells**.
  - It is **structurally similar to DNA** but typically **single-stranded**.
  - Its backbone consists of alternating **phosphate groups and ribose sugars**, with bases **adenine (A), uracil (U), cytosine (C), and guanine (G)**.
- **Types of RNA:**
  - **Messenger RNA (mRNA):** Carries genetic information from DNA to ribosomes for protein synthesis.
  - **Ribosomal RNA (rRNA):** Forms the core of the ribosome's structure and catalyses protein

synthesis.

- **Transfer RNA (tRNA):** Transfers amino acids to ribosomes during protein synthesis.
- **Regulatory RNAs:** Play roles in gene expression regulation.
- **Functional Significance:** RNA plays essential roles in cellular processes like building cells, immune responses, and transporting amino acids.
- **Role in Viruses:** Certain **viruses** use RNA as their **genetic material**.

### How do RNA and DNA Editing Differ?

Aspect	DNA Editing	RNA Editing
<b>Permanence vs. Temporariness</b>	<b>Permanent:</b> Alters an individual's <b>genome permanently</b> , which may lead to <b>irreversible errors</b> if issues occur.	<b>Temporary:</b> Makes temporary changes in RNA that <b>fade over time</b> , providing <b>flexibility</b> to discontinue therapy if problems arise, reducing long-term risks.
<b>Immune Response</b>	Often uses <b>CRISPR-Cas9</b> or other tools derived from <b>bacteria</b> , which can <b>trigger immune reactions</b> due to foreign proteins.	Utilises <b>ADAR enzymes</b> naturally present in <b>human cells</b> , posing a <b>lower risk of immune or allergic responses</b> . Suitable for repeated treatments and those with immune sensitivities.

### UPSC Civil Services Examination, Previous Year Questions (PYQs)

**Q. In the context of recent advances in human reproductive technology, “Pronuclear Transfer” is used for (2020)**

- (a) fertilization of egg in vitro by the donor sperm
- (b) genetic modification of sperm producing cells
- (c) development of stem cells into functional embryos
- (d) prevention of mitochondrial diseases in offspring

**Ans: (d)**

**Q. What is Cas9 protein that is often mentioned in news? (2019)**

- (a) A molecular scissors used in targeted gene editing
- (b) A biosensor used in the accurate detection of pathogens in patients
- (c) A gene that makes plants pest-resistant
- (d) A herbicidal substance synthesised in genetically modified crops

**Ans: (a)**

**Q. With reference to the recent developments in science, which one of the following statements is not correct?(2019)**

- (a) Functional chromosomes can be created by joining segments of DNA taken from cells of different species.

(b) Pieces of artificial functional DNA can be created in laboratories.

(c) A piece of DNA taken out from an animal cell can be made to replicate outside a living cell in a laboratory.

(d) Cells taken out from plasma and animals can be made to undergo cell division in laboratory petri dishes.

**Ans: (a)**

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