

## MicroRNA and Gene Regulation

### Why in News?

2024 Nobel Prize for Medicine was awarded to Ambros and Ruvkun for their discovery of Gene regulation by microRNA.

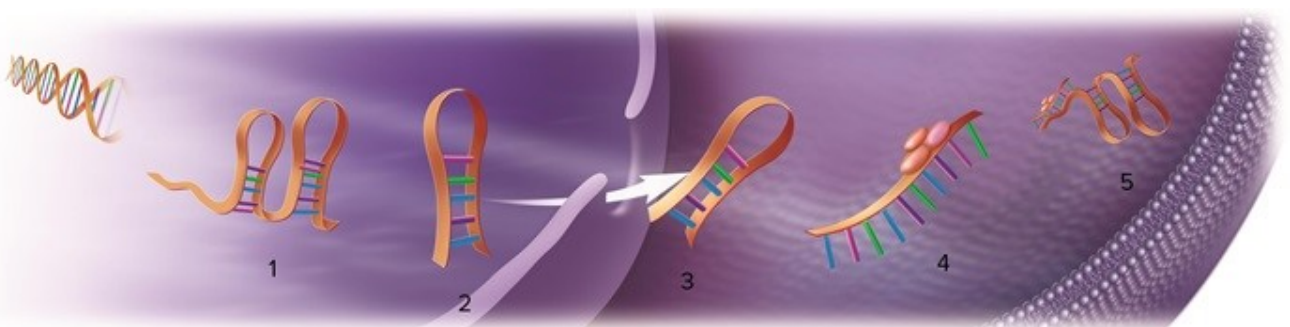
### What is MicroRNA?

- **MicroRNA** - These are a new class of tiny RNA molecules that play a crucial role in gene regulation for nearly all multicellular organisms, including humans.
- Human genome codes for over one thousand microRNAs.
- **Function of MicroRNA** - It controls gene expression mainly by binding with messenger RNA (mRNA) in the cell cytoplasm during the transcription process.

*Transcription is the flow of genetic information from DNA to messenger RNA (mRNA), and then on to the cellular machinery for protein production.*

*Gene expression refers to whether a particular gene is making too much, too little or the normal amount of its protein at a particular time.*

- Instead of being translated quickly into a protein, the marked mRNA will be either destroyed and its components recycled, or it will be preserved and translated later.
- A single microRNA can regulate the expression of many different genes, and conversely, a single gene can be regulated by multiple microRNAs.
- **MicroRNA Production** - Cells have genes that encode the information for making microRNA.
- Cells make microRNA using a process that resembles the early steps of protein synthesis.
- The microRNA gene is activated, the DNA strand opens up and the gene is copied, or transcribed, in the form of RNA.

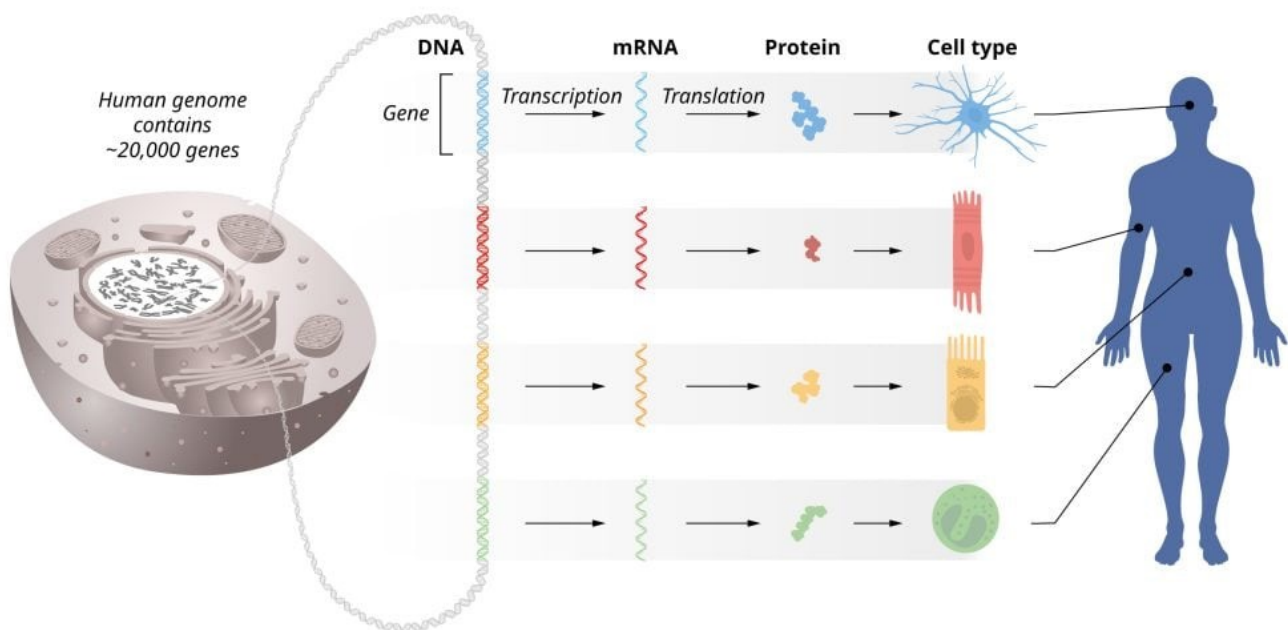


## What is gene regulation?

- **Gene Regulation** - It is the fundamental principle governing how gene activity is regulated.
- Chromosomes inside the nucleus of each cell carry genetic information in the form of DNA.
- Every cell in the body has the same chromosome, containing same identical genes.
- But different cells need to use different genes depending on their function and Different tissues in the body create different proteins, depending on their specific functions.

*Proteins handle all kinds of important jobs in the body, such as making muscles contract or helping nerves communicate.*

- Gene regulation process helps each cell pick the right gene from its chromosome for its specific tasks and activate appropriate set of genes in each type of cell.
- This enables, for example, muscle cells, intestinal cells, and different types of nerve cells to perform their specialized functions.

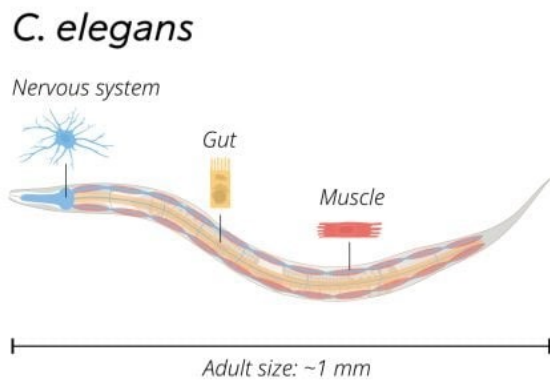


## How was it discovered?

- **C. elegans** - It is a small roundworm of length 1mm.
- Despite its small size, it possesses many specialized cell types such as nerve and muscle cells that are found in larger, more complex animals.
- It is a useful model for investigating how tissues develop and mature in multicellular organisms.
- Ambros and Ruvkun studied the two mutant gene strains of worms, *lin-4* and *lin-14* that displayed defects in the timing of activation of genetic programs during development.

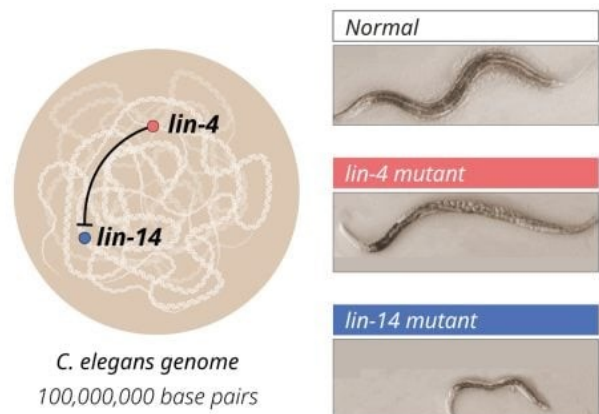
- The *lin-4* gene produced an unusually short RNA molecule that lacked a code for protein production.
- Using this short RNA, *lin-4* gene acted as the negative regulator of the *lin-14* gene by blocking its activity.
- Over the following years, more than a thousand genes for different microRNAs in humans were discovered.

**A**

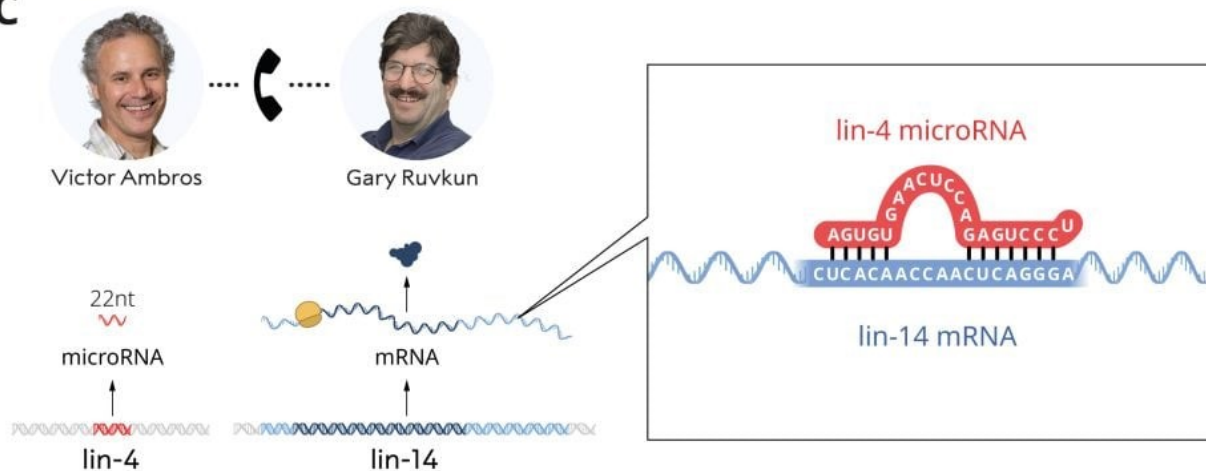


**B**

*lin-4* and *lin-14* mutants



**C**



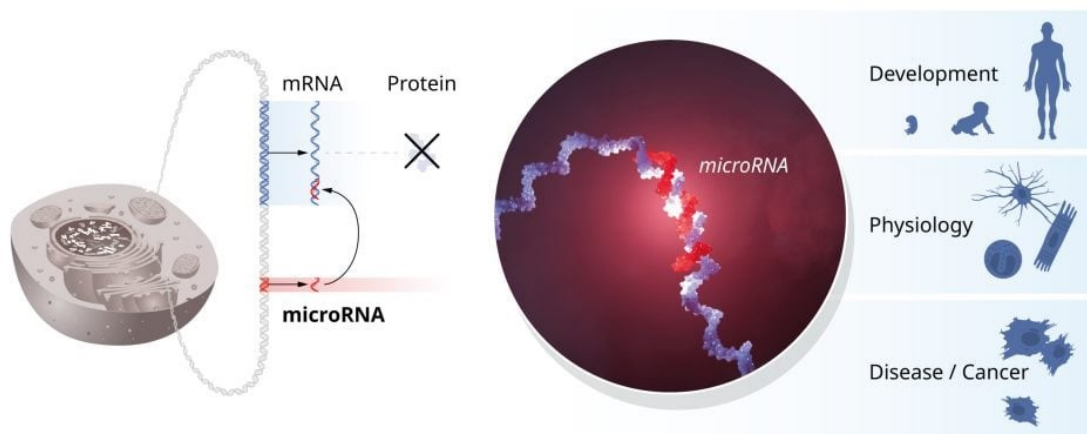
### What are the Significances of Micro RNA?

- Discovery of microRNA helped in understanding how bodies of complex organisms such as humans function work.
- **Role in Evolution** - Gene regulation by microRNA has enabled the evolution of increasingly complex organisms.
- **Role in Development** - MicroRNA enabled the differentiation of cells to form different types of cells.
- **Understanding diseases** - Faults in gene regulation can result in serious diseases like cancer, diabetes, or autoimmune conditions.
- Understanding gene regulation helps in understanding and potentially treating many of these conditions.

Mutations in one of the proteins required for microRNA production result in the *DICER1 syndrome*, a rare but severe syndrome linked to cancer in various organs and tissues.

- **RNA production** - Cellular machinery for producing functional microRNAs is used to produce other small RNA molecules in both plants and animals, for example as a means of protecting plants against virus infections.

*Andrew Z. Fire and Craig C. Mello, awarded the Nobel Prize in 2006, for RNA interference, where specific mRNA-molecules are inactivated by adding double-stranded RNA to cells.*



## References

1. [The Indian Express | Nobel Prize for Medicine](#)
2. [Nobel Prize | Discovery of microRNA](#)