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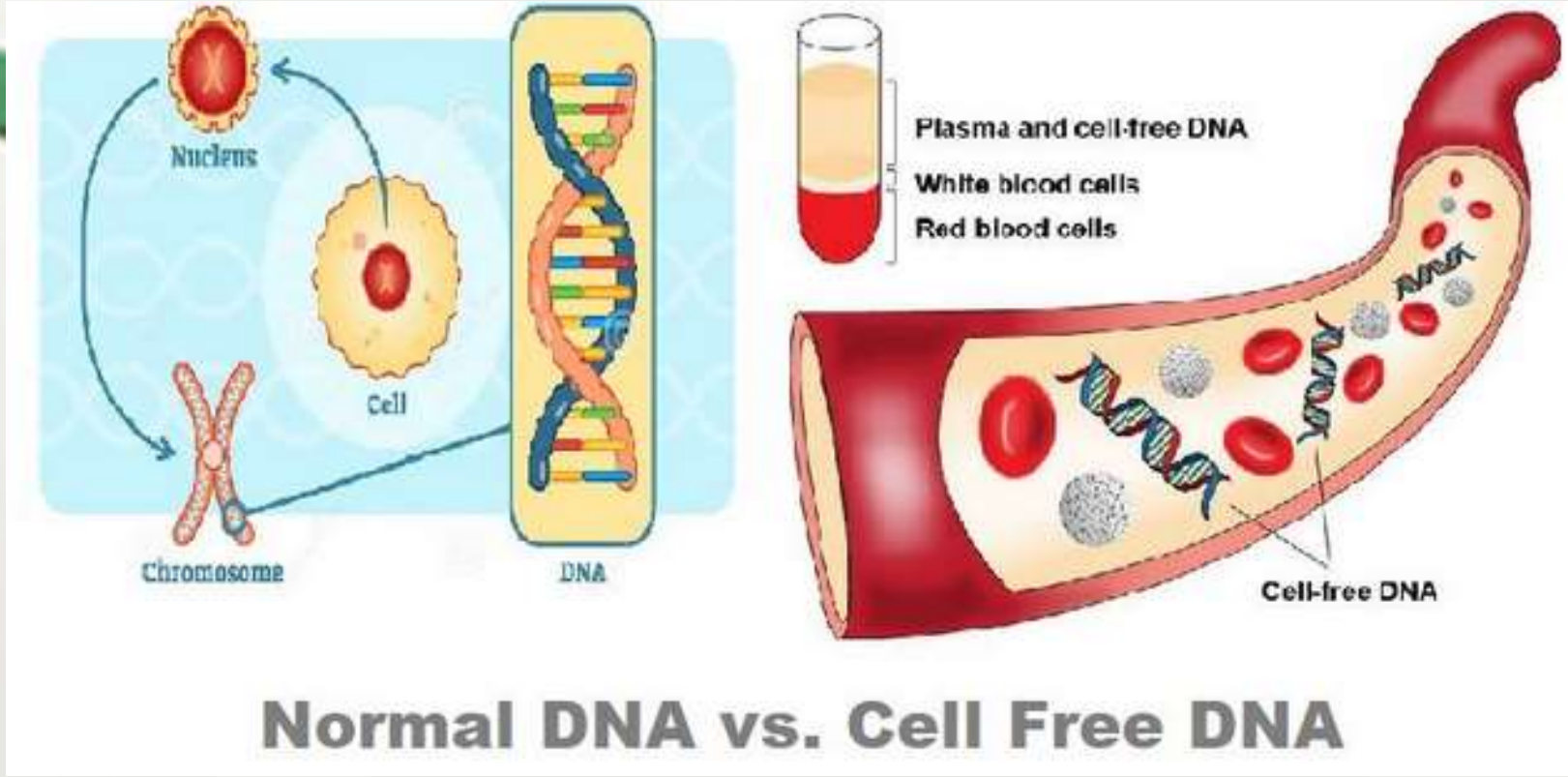
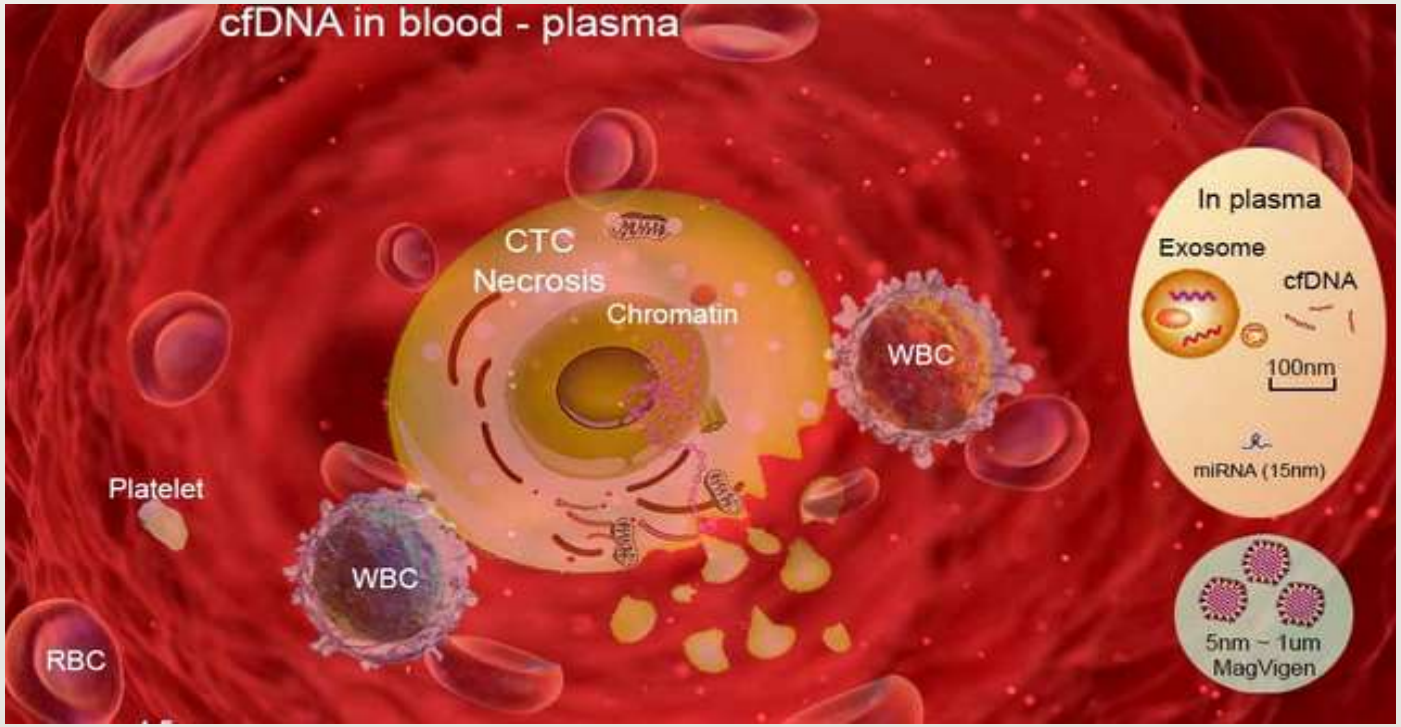
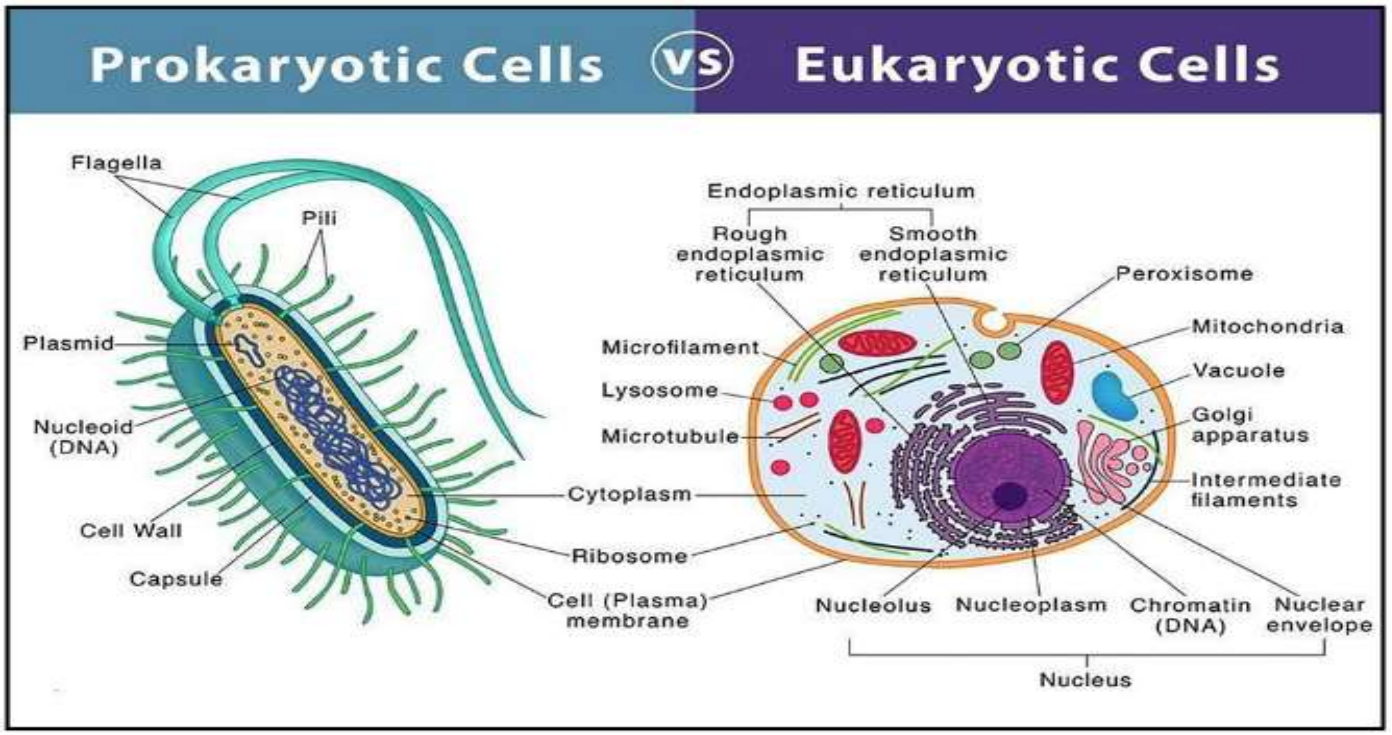
Cell-Free DNA

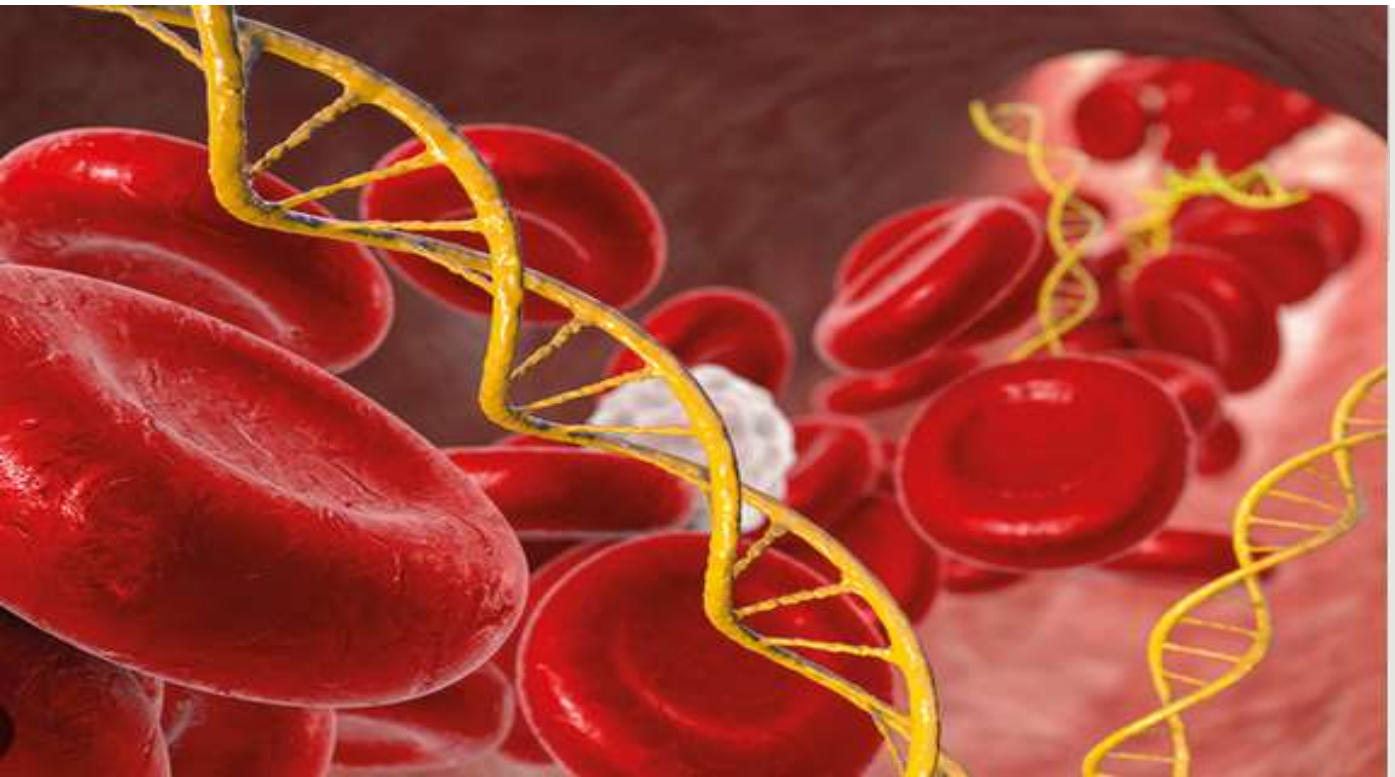


Why in News?

- A notable advancement in medical science has emerged in recent years through the discovery of cell-free Deoxyribonucleic Acid (cfDNA),
- Carrying significant implications for disease detection, diagnosis, and treatment.

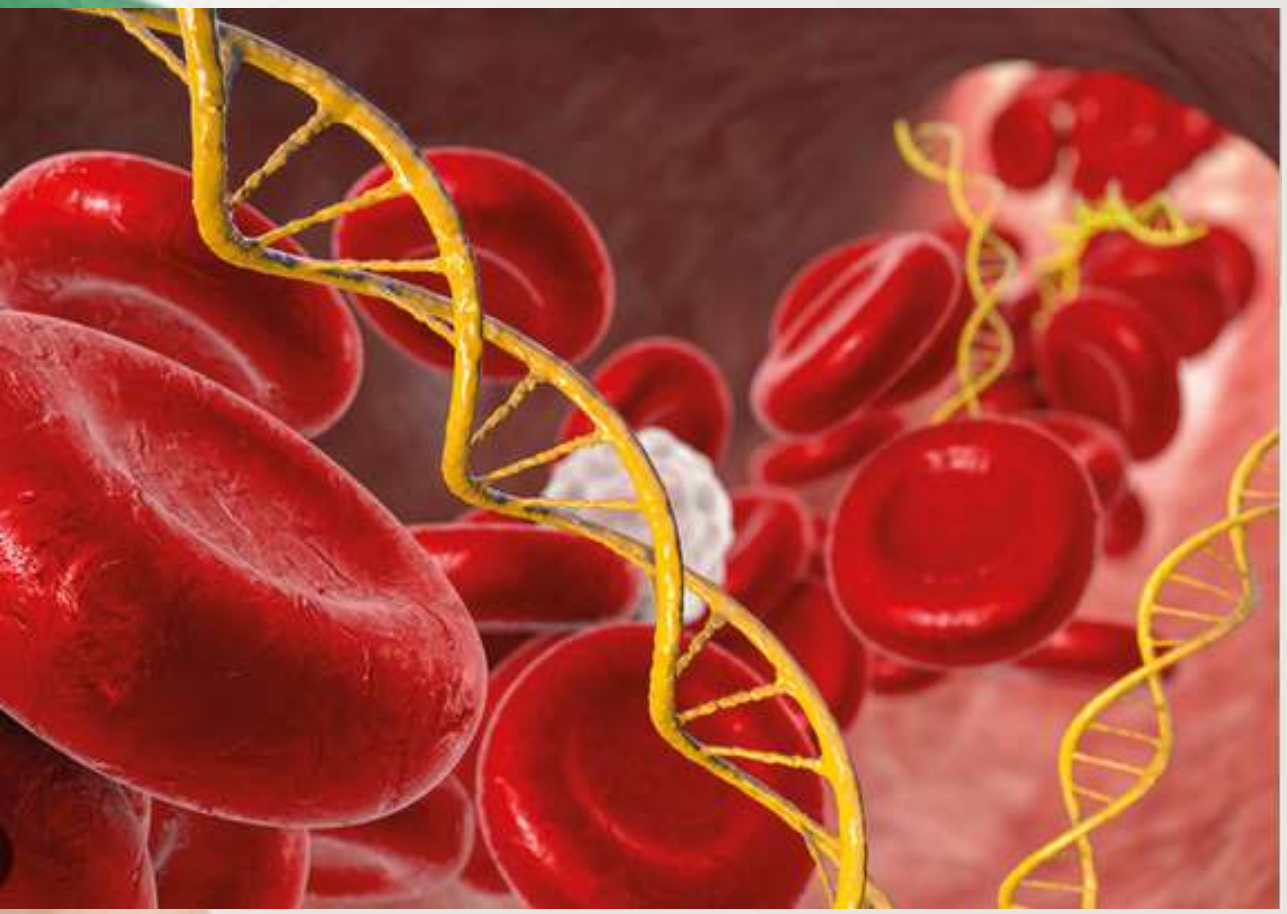




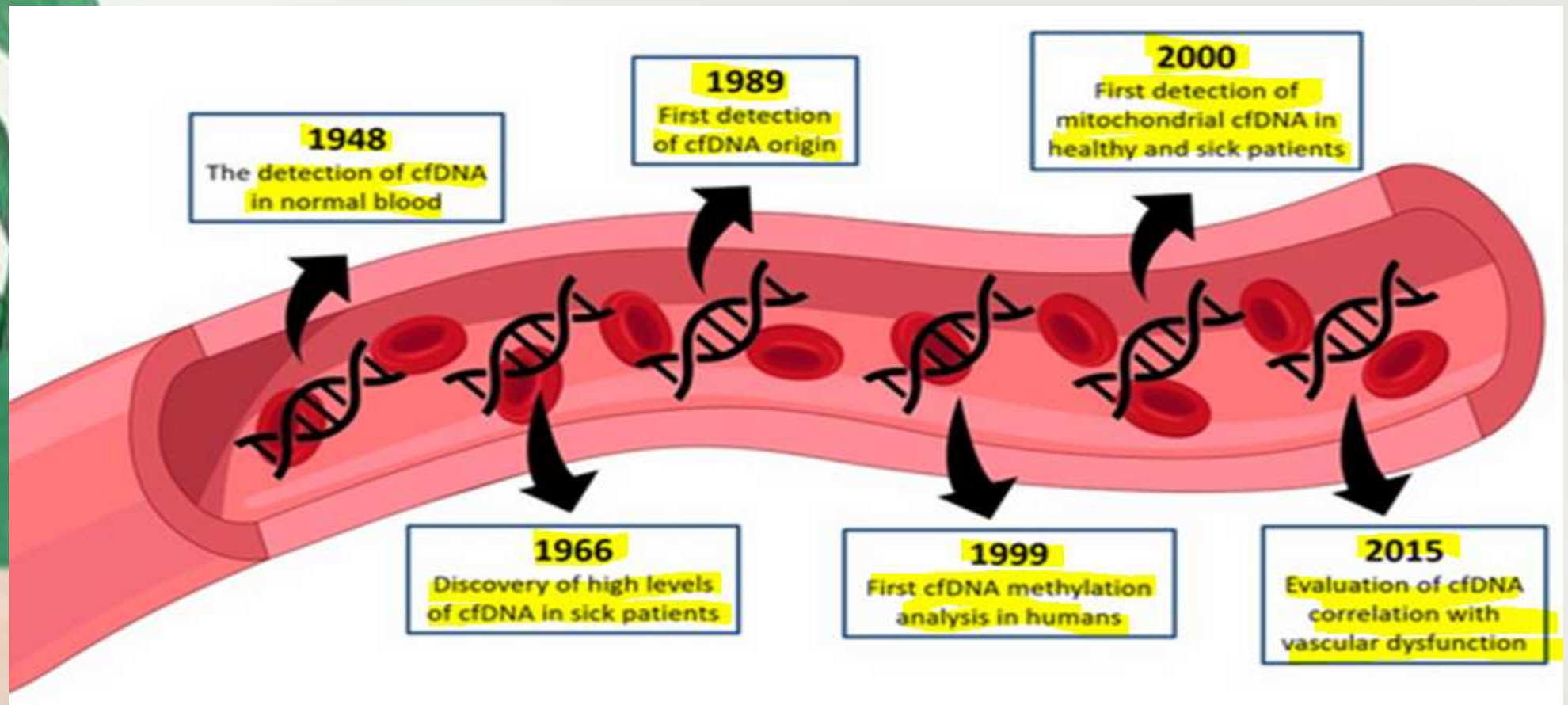


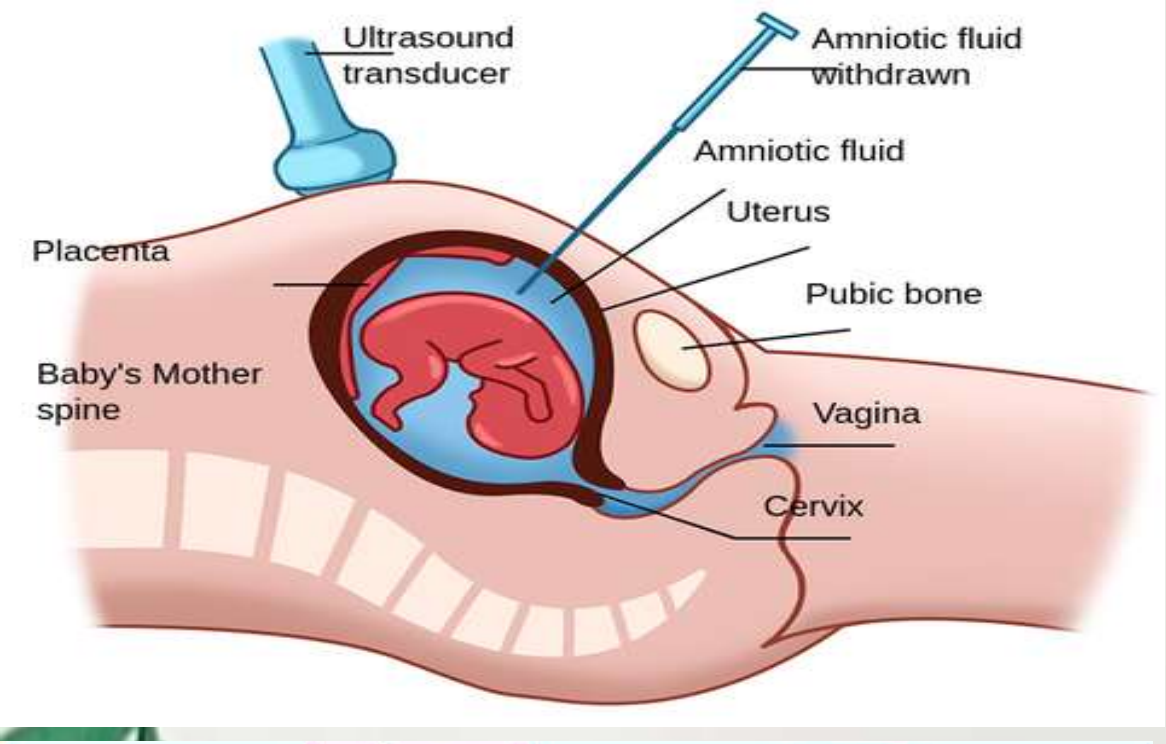
- **What is Cell-Free DNA**

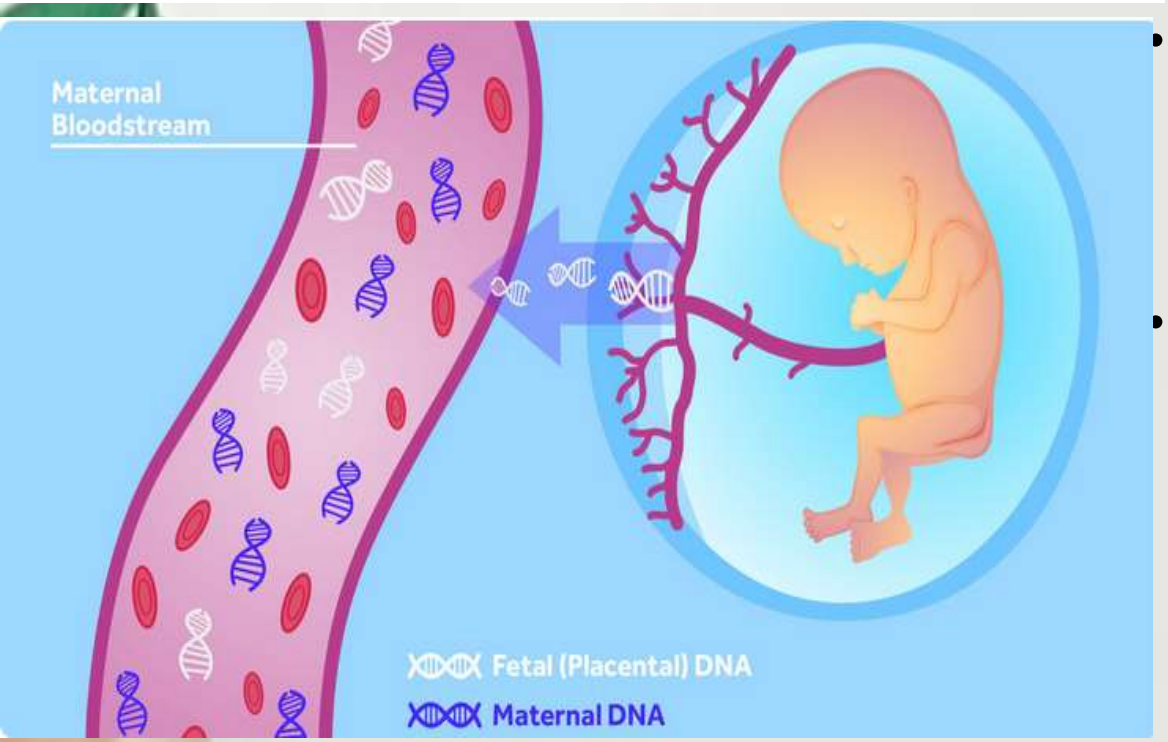
- **Cell-Free DNA refers to fragments of DNA that exist outside of cells, specifically in various body fluids.**



- cfDNA is released into the extracellular environment under different circumstances, including cell death or other cellular processes.
- These cfDNA fragments contain genetic information and can offer insights into a person's health status, potential diseases, and genetic variations.


1948
The detection of cfDNA in normal blood
1966
Discovery of high levels of cfDNA in sick patients
1989
First detection of cfDNA origin
1999
First cfDNA methylation analysis in humans
2000
First detection of mitochondrial cfDNA in healthy and sick patients
2015
Evaluation of cfDNA correlation with vascular dysfunction





Applications of Cell-free DNA

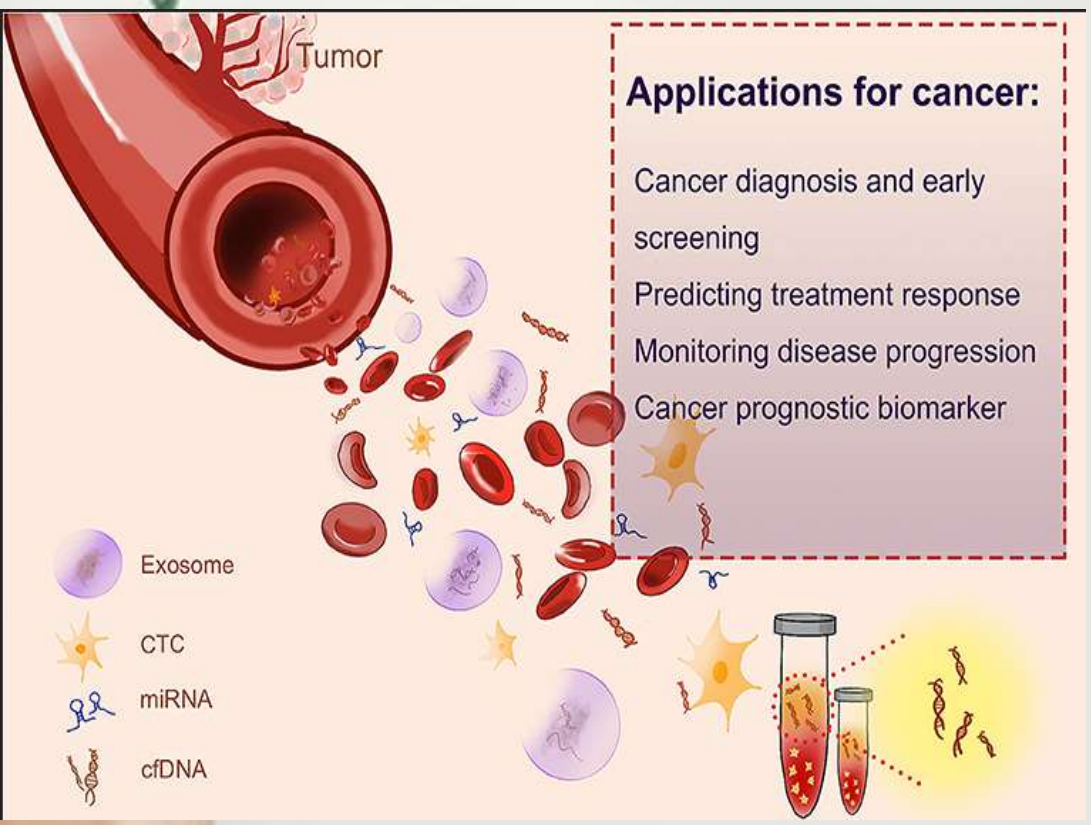
Non-Invasive Prenatal Testing (NIPT):

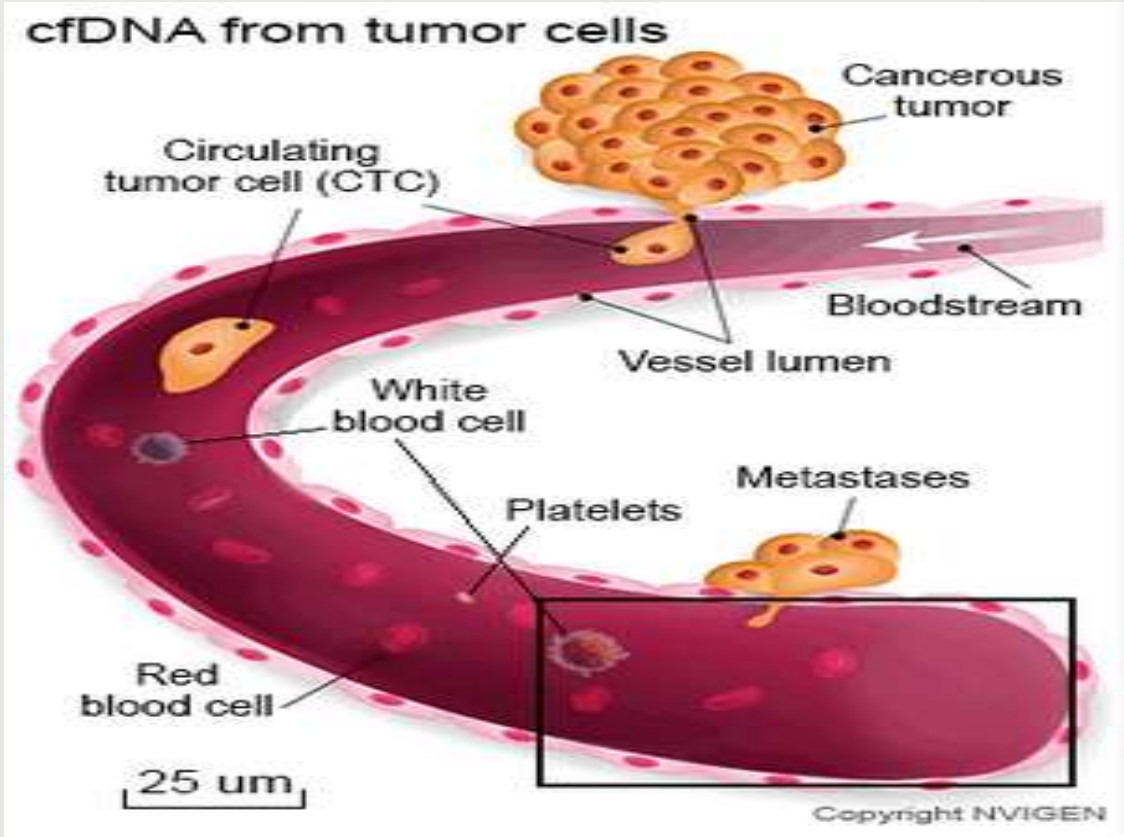
Cell-free DNA serves as a valuable tool for screening chromosomal abnormalities in developing fetuses, such as Down syndrome.

- NIPT replaces invasive procedures such as amnio-centesis, minimizing risks for both expectant mothers and fetuses.
- Analysis of cf-DNA in maternal blood provides crucial information about the foetus's genetic health.

Early Cancer Detection:

- **Identifying cancers at their initial stages for prompt treatment.**
- **Eg. The 'GEMINI' test utilizes cfDNA sequencing to detect lung cancer with high accuracy.**





Monitoring Organ Transplants:

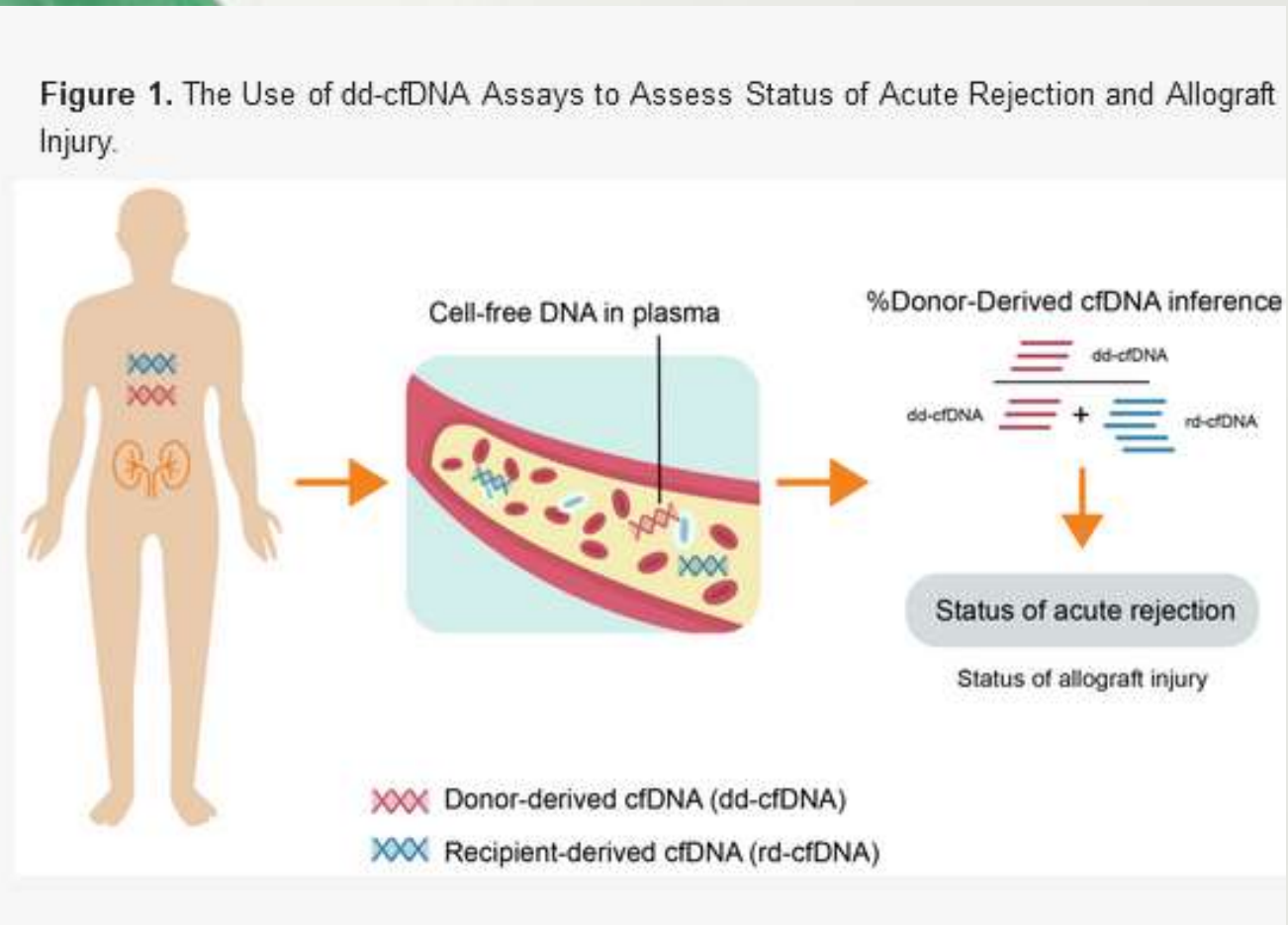


Figure 1. The Use of dd-cfDNA Assays to Assess Status of Acute Rejection and Allograft Injury.

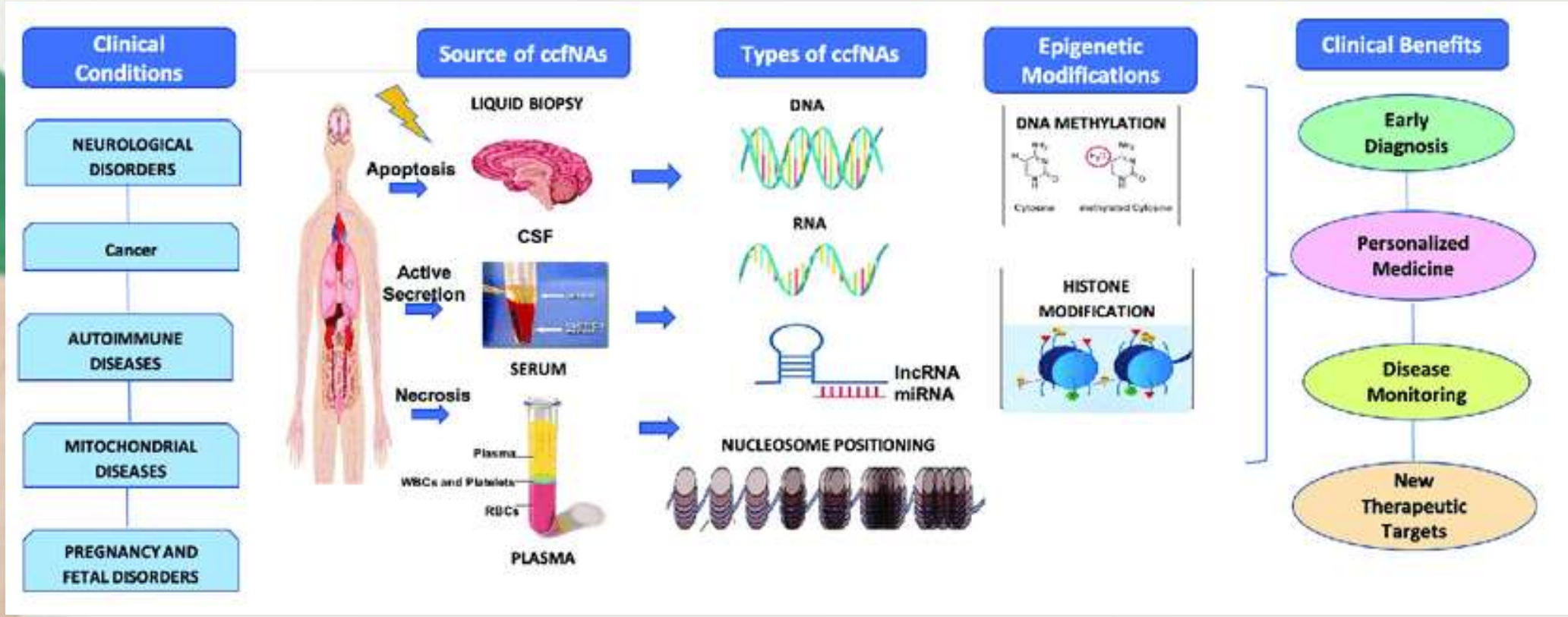
- **Donor-derived cell free DNA offers a promising approach to monitor the health and acceptance of transplanted organs.**
- **Fluctuations in cfDNA levels can indicate organ rejection or acceptance before other markers become evident.**
- **Early detection of rejection allows for timely intervention and improved outcomes in organ transplantation.**

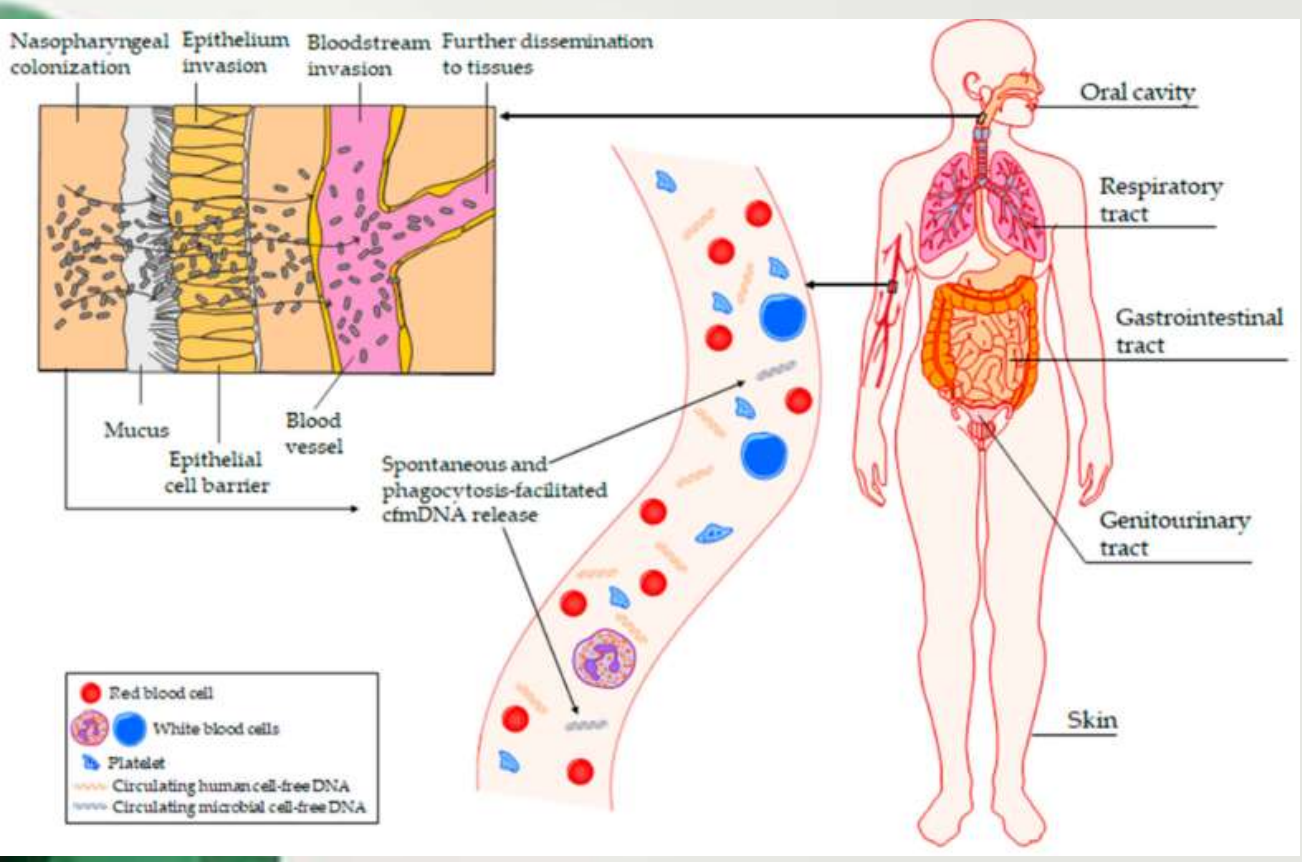
Neurological Disorder Biomarkers:

- Aiding in the diagnosis and monitoring of conditions like Alzheimer's disease, neuronal tumors, and stroke.

Metabolic Disorder Insights:

- Detection and management of conditions such as type-2 diabetes and non-alcoholic fatty liver disease.





Advancing Disease Research

- The versatility of cfDNA applications contributes to a deeper understanding of complex diseases and their underlying genetic factors

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