Cell-Free DNA

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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.**

- cfDNA stands poised to reshape the entire landscape of medical science.

What is Cell-Free DNA (cfDNA)?

- **About:**
    - cfDNA refers to **fragments of DNA that exist outside of cells,** specifically in various body fluids. Unlike the majority of **DNA which is enclosed within cells.**
    - Scientists have been aware of **cfDNA since 1948, but only in the last two decades have they figured out what to do with it.**
    - 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.
- **Applications:**
    - **Non-Invasive Prenatal Testing (NIPT):**
        - Cell-free DNA serves as a valuable tool for **screening chromosomal abnormalities** in developing foetuses, such as Down syndrome.
        - NIPT replaces invasive procedures such as amniocentesis, minimizing risks for both expectant mothers and foetuses.
        - Analysis of **cfDNA in maternal blood** provides crucial information about the **foetus's genetic health.**
    - **Early Cancer Detection:**
        - Identifying **cancers at their initial stages** for prompt treatment.
        - The **'GEMINI' test** utilizes **cfDNA sequencing to detect lung cancer with high accuracy.**
        - Combining cfDNA analysis with existing methods enhances overall cancer detection.
    - **Monitoring Organ Transplants:**
        - Donor-derived cfDNA 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:**
    - Investigating cfDNA's potential as a **biomarker for neurological disorders.**
    - Aiding in the **diagnosis and monitoring of conditions like Alzheimer's disease**, neuronal tumours, and stroke.
- **Metabolic Disorder Insights:**
    - Exploring cfDNA's role as a biomarker for metabolic disorders.
    - Detection and management of conditions such as **type-2 diabetes** and **non-alcoholic fatty liver disease.**
- **Advancing Disease Research:**
    - Researchers use cfDNA analysis to study disease mechanisms, monitor treatment effectiveness, and gain insights into disease pathways.
    - The versatility of cfDNA applications contributes to a deeper understanding of complex diseases and their underlying genetic factors.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

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)

- In 2017, US researchers were successful in developing new semi-synthetic strain of E. coli bacteria that is a living organism that incorporates both natural and artificial DNA and is capable of creating entirely new, synthetic proteins
- A wide variety of double stranded DNA templates are replicated extensively in an in-vitro DNA replication system containing purified proteins.
- Through micro propagation, plants can be developed in the laboratory, for instance, chlamydomnas cells can be replicated in culture through light variations. Therefore, option (a) is the correct answer.

Q. With reference to agriculture in India, how can the technique of 'genome sequencing', often seen in the news, be used in the immediate future? (2017)

1. Genome sequencing can be used to identify genetic markers for disease resistance and drought tolerance in various crop plants.
2. This technique helps in reducing the time required to develop new varieties of crop plants.
3. It can be used to decipher the host-pathogen relationships in crops.

Select the correct answer using the code given below:

(a)1only
(b)2and3only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans: (d)

- Chinese scientists decoded rice genome in 2002. The Indian Agricultural Research Institute (IARI) scientists used the genome sequencing to develop better varieties of rice such as Pusa Basmati-1 and Pusa Basmati-1121, which currently makes up substantially in India's rice export.
- In genome sequencing it takes less time. The genome sequencing enables the study of the entire DNA sequence of a crop, thus it aids in understanding of pathogens' survival or breeding zone.