**MITOCHONDRIAL REPLACEMENT THERAPY (MRT) – SCIENCE & TECHNOLOGY**

NEWS: Eight healthy babies were born in Britain with the help of an **experimental technique called Mitochondrial Replacement Therapy (MRT).**

WHAT'S IN THE NEWS?

**Background and Global Significance**

- **High-Risk Mothers**: The mothers who underwent the treatment carried **mutations in their mitochondrial DNA**, putting their children at high risk of **life-threatening mitochondrial disorders**.
- **Successful Births**: Eight healthy babies (four boys and four girls) were born to **seven women** using mitochondrial donation treatment, with **no signs** of the mitochondrial diseases they were at risk of inheriting.
- **UK Leadership**: The **United Kingdom became the first country in the world** to formally approve the use of **mitochondrial donation therapy (MDT)** in 2015.
- **India's Legal Status**: As of now, **India does not permit** the use of mitochondrial donation or replacement therapies.

**Understanding Mitochondrial Genes**

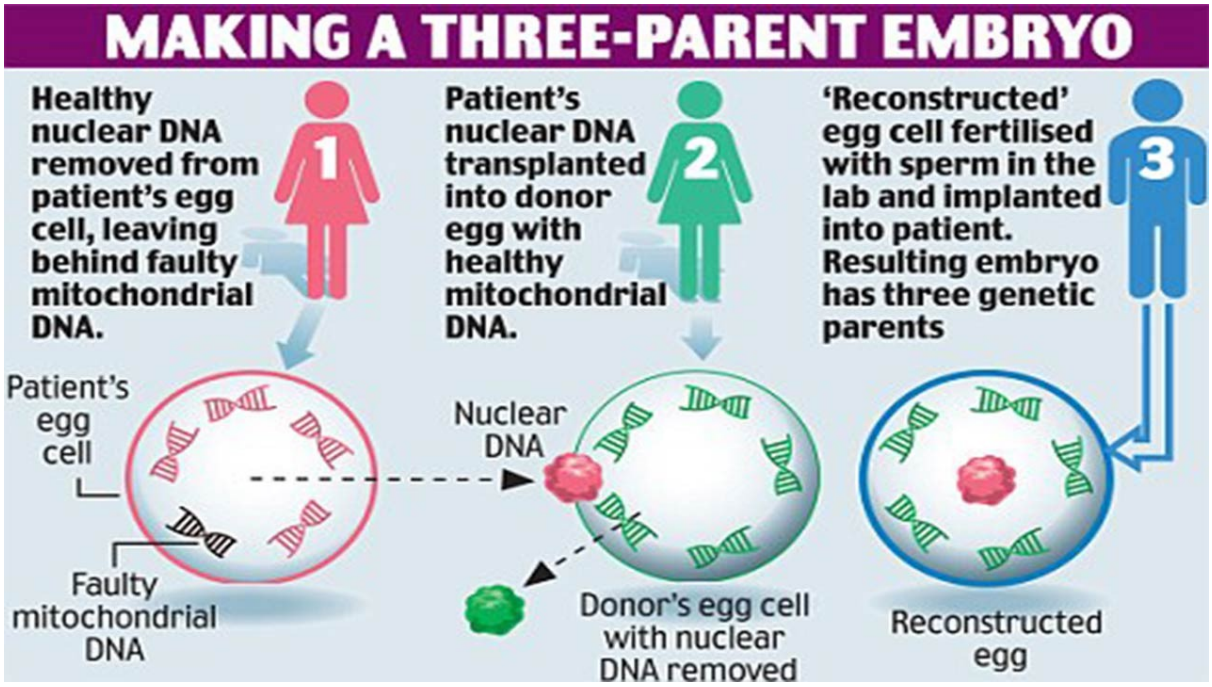
- **What Are Mitochondria?**
  Mitochondria are **membrane-bound organelles** found in almost every human cell, often referred to as the "**powerhouses of the cell**" due to their role in **energy production** (via ATP).
- **Mitochondrial DNA**: Unlike nuclear DNA, mitochondria have their **own circular DNA**, with **37 genes** essential for normal mitochondrial function.
- **Maternal Inheritance**: All **mitochondrial DNA is inherited from the mother**, which means any mutation in her mitochondria is **passed on to all her children**.

What is Mitochondria?

- **About:**
  - Mitochondria are **membrane-bound organelles** found in the cells of most **eukaryotic organisms.**
  - They are often referred to as the **"powerhouses" of cells** because they generate the **majority of the cell's energy** in the form of **adenosine triphosphate (ATP).**
- **Functions:**
  - Mitochondria carry out **cellular respiration,** a process that converts nutrients into ATP.
  - Mitochondria convert energy from **carbohydrates, fats, and proteins into a usable form for the cell.**
  - They metabolize **glucose to produce ATP,** which powers various cellular processes.

- Mitochondria participate in **cell signaling pathways,** influencing processes like **cell growth, differentiation, and apoptosis.**

- **Inheritance:**
  - Mitochondria have their own DNA, known as **mitochondrial DNA (mtDNA),** which encodes a **small number of essential proteins.**
  - In most animals, **mtDNA is inherited solely from the mother.**
  - Mutations in mtDNA can lead to **mitochondrial disorders** and various health conditions.
- **Mitochondrial Diseases:**
  - Certain mutations in mitochondria can lead to mitochondrial diseases, **affecting energy production and impacting various organs**, including the brain, nerves, muscles, kidneys, heart, and liver.
  - These diseases can result in severe symptoms, such as **organ failure, muscle wastage, and even brain damage.** Unfortunately, there is **no cure for mitochondrial diseases,** but they can be managed to some extent.
  - Few examples of mitochondrial diseases are **Leigh Syndrome, Kearns-Sayre syndrome (KSS)**, Mitochondrial Myopathy and Mitochondrial DNA Depletion Syndrome.



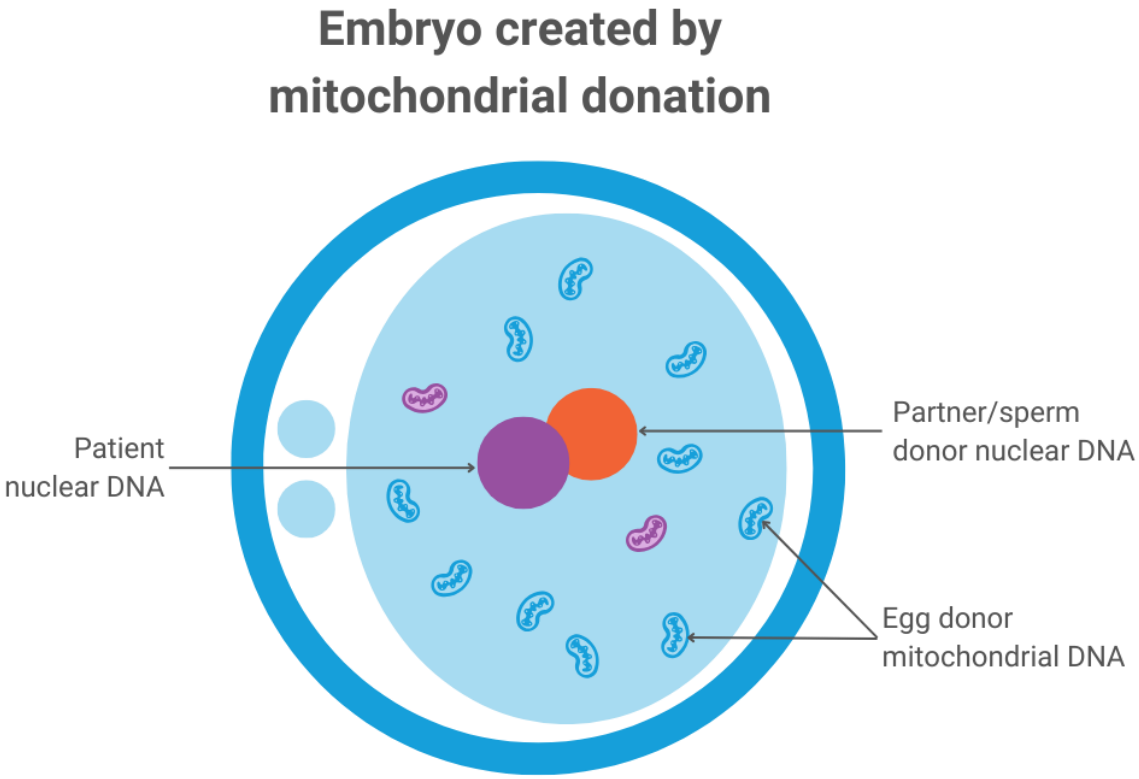

**Impact of Mitochondrial Diseases**

- **Mode of Inheritance**: Since mitochondria come only from the egg (not sperm), **mutations in a mother's mitochondria** are transmitted to **all her biological children**.
- **Health Consequences**:

- Mitochondrial diseases affect organs that require **high energy**, like the **brain, heart, and muscles**.
- Symptoms often appear in **early childhood**.
- Children may face **developmental delays**, **muscle weakness**, may require **wheelchairs**, and in severe cases, may **die young**.
- Approx. **1 in 5,000 births** is affected by some form of mitochondrial disorder.

**Mitochondrial Donation Treatment (MDT)**

- **Also Called**:
  - Mitochondrial Replacement Therapy (MRT)
  - Three-Parent Baby Technique
  - Three-Person In Vitro Fertilisation (IVF)
- **Objective**: Prevent the **transmission of defective mitochondria** from mother to child, thereby eliminating mitochondrial diseases **before birth**.




**Procedure: How MDT Works**

- **Step-by-Step**:
  1. **Eggs are collected** from both the affected mother and a healthy female donor.

2. The mother's egg is **fertilized with the father's sperm**, forming an embryo with **mutated mitochondria**.
3. The **nuclear genetic material** from the fertilized embryo is **transferred into a donor egg** that has had its own nucleus removed but contains **healthy mitochondria**.
4. The new embryo now contains:
    - **Nuclear DNA from the biological mother and father**
    - **Healthy mitochondrial DNA from the donor woman**
5. This embryo is then **implanted into the womb**, and if successful, results in a pregnancy.

- **Genetic Outcome**: The resulting baby carries **99.8% of DNA** from the biological parents and **0.2% from the mitochondrial donor**.

**Ethical and Scientific Importance**

- **Ethical Discussions**:
    - Involves **germline modification**, which is inheritable by future generations.
    - Raises questions on **parental identity**, **regulation**, and **long-term effects**.
- **Scientific Breakthrough**:
    - Represents a **new frontier in genetic medicine**.
    - Converts an **inherited disorder prevention technique** into a **potential reproductive option** for at-risk families.

**Global Outlook and Future Prospects**

- **Ongoing Global Monitoring**: Scientists across the world are observing the UK results for **long-term safety, efficacy**, and **ethical acceptability**.
- **Potential for Wider Use**:
    - With **strong regulation and safety protocols**, MDT may become a **standard medical option** for families carrying mitochondrial mutations.
    - May also influence **gene therapy, IVF practices**, and **genomic medicine policy** globally.

Source: https://www.livemint.com/news/trends/medical-breakthrough-in-uk-babies-born-after-ivf-using-dna-from-three-people-11752750527061.html