



# Mitochondrial Replacement Therapy

## Why in News?

The recent news of a **baby born in the UK with three parents' DNA** has sparked curiosity and discussions about the scientific breakthrough behind this remarkable achievement.

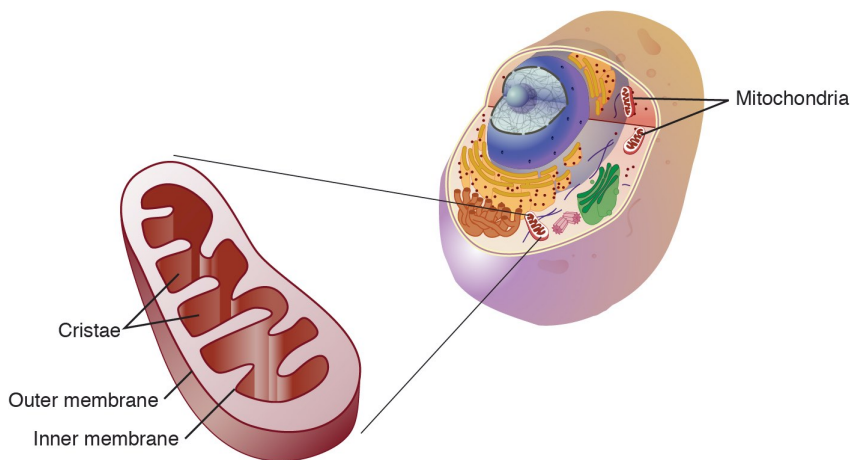
- This revolutionary technique, known as **mitochondrial replacement therapy (MRT) or three-parent IVF**, aims to prevent the **inheritance of mitochondrial diseases**.

## 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)**.

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### ▪ 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.

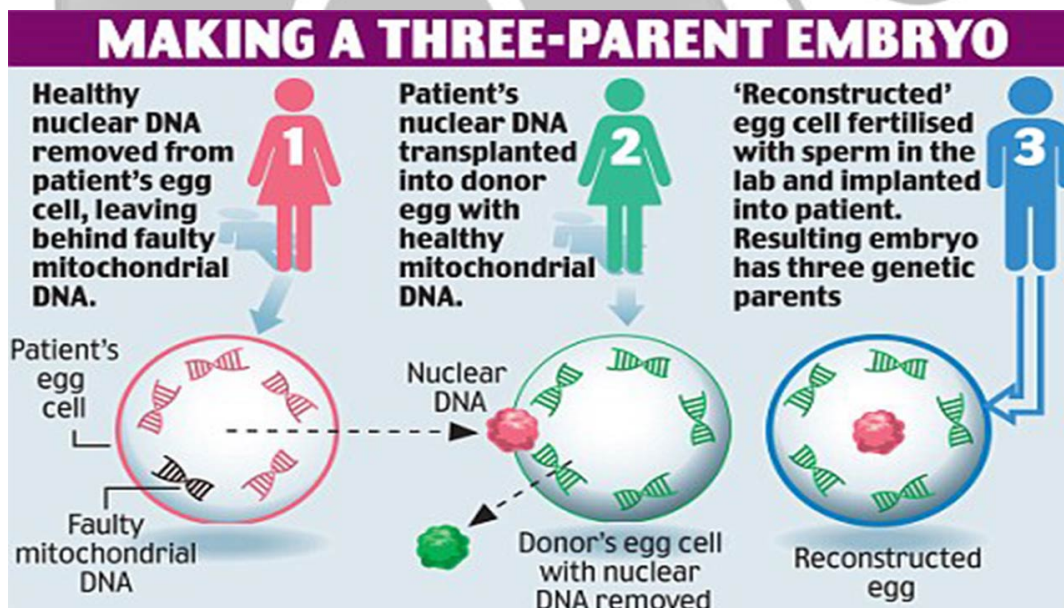
## What is Mitochondrial Donation Treatment (MDT)/MRT?

### ▪ About:

- To address the issue of mitochondrial diseases, scientists and researchers developed an **advanced In Vitro Fertilization (IVF) technique** called **Mitochondrial Donation Treatment (MDT) or three-parent IVF**.
  - This technique involves a complex process to ensure that the **baby inherits healthy mitochondria** while carrying the **genetic material from both biological parents**.

### ▪ The Scientific Process:

- **Identifying Suitable Candidates:**
  - The procedure is specifically **intended for couples** who wish to have their **genetic child** but do not want to use a donor egg.
- **Selection of Donor and Biological Parents:**
  - The **biological mother**, who has a **mitochondrial disease**, provides **her eggs**, which are fertilized by the **biological father's sperm**.
    - Additionally, a **separate female donor with healthy mitochondria** is involved.
- **Mitochondrial Replacement:**
  - The **genetic material (DNA) from the donor's egg** is **extracted and replaced** with the **genetic material from the biological parents**.
    - This creates an **embryo with the parents' DNA and the donor's mitochondria**.
- **Implantation and Pregnancy:**
  - The modified embryo is then **implanted in the uterus** and carried to full term, resulting in the birth of a **baby free from the mother's mitochondrial disease**.



### ▪ Potential Side Effects:

- While the procedure has shown promising results, it is not without minimal risks. In some cases, a small amount of **faulty maternal mitochondria** may be inadvertently passed on

during the procedure.

- Further research and published data are needed to establish consensus and refine the technique for improved outcomes.

▪ **Legislation and Approval:**

- The **UK government amended its law in 2015 to allow mitochondrial replacement therapy**, and the Newcastle Fertility Centre became the first licensed center to perform the procedure in 2017.

▪ **Mitochondrial Disease Statistics:**

- Globally, an estimated 1 in 5,000 people have a genetic mitochondrial disease.
  - Mitochondrial disorders affect approximately **one in 6,500 babies in the UK, and around 12,000 people in the country** live with such conditions.
  - In the United States, an estimated 1,000 to 4,000 babies with mitochondrial disease are born each year.

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

### Q1. In the context of hereditary diseases, consider the following statements: (2021)

1. Passing on mitochondrial diseases from parent to child can be prevented by mitochondria replacement therapy either before or after in vitro fertilization of the egg.
2. A child inherits mitochondrial diseases entirely from mother and not from father.

**Which of the statements given above is/are correct?**

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

**Ans: (c)**

**Source: TH**

PDF Reference URL: <https://www.drishtiias.com/printpdf/mitochondrial-replacement-therapy>