Casgevy Therapy for Sickle Cell Disease and Thalassaemia

Source: IE

Why in News?

Recently, the **UK Drug Regulator** sanctioned a **gene therapy** **called Casgevy** heralded as a significant breakthrough for **treating** sickle cell disease **and** thalassaemia.

- Notably, this marks the **world's inaugural licensed therapy leveraging the CRISPR-Cas9 gene editing technology** that earned its innovators a **Nobel Prize in Chemistry 2020.**

How does the Casgevy Therapy Work?

- Both **sickle cell disease and thalassaemia** are caused by **errors in the gene for** haemoglobin(Hb), a protein in the red blood cells that carry oxygen to organs and tissues.
    - The therapy **uses the patient's own blood stem cells**, which are precisely **edited using** CRISPR-Cas9.
    - A gene called **BCL11A**, which is crucial for switching from **foetal to adult haemoglobin**, is targeted by the therapy.
- **Foetal haemoglobin**, which is naturally present in everyone at birth, does not carry the same abnormalities as adult haemoglobin.
    - The therapy **uses the body's own mechanisms to start producing more of this foetal haemoglobin,** alleviating the symptoms of the two conditions.
- Casgevy involves a single treatment wherein **blood stem cells are extracted via apheresis** and then edited over approximately six months before being reintroduced into the patient.
    - Apheresis is a medical procedure that involves removing specific components from blood and returning the rest to the body.

What are Sickle Cell Disease and Thalassaemia?

- **Sickle Cell Disease:**
    - **About:** Sickle cell disease is a genetic blood disorder characterized by an abnormality in hemoglobin, the **protein responsible for carrying oxygen in red blood cells.**
        - It causes **red blood cells to adopt a sickle or crescent shape,** hindering their movement through vessels, leading to potential complications like **severe pain, infections, anaemia, and strokes.**
        - In India alone, an estimated **30,000-40,000 children** are born with sickle cell disease annually.
    - **Types**: It encompasses various types, each dependent on the **inherited genes from parents**, all encoding abnormal hemoglobin. The most prevalent forms of SCD include:
        - **HbSS (Sickle Cell Anemia):** Individuals **inherit two "S" genes,** one from each parent, resulting in **abnormal hemoglobin "S."**
            - This type often leads to severe manifestations characterized by **rigid, sickle-shaped red blood cells.**
        - **HbSC:** Inheriting an "**S" gene from one parent and a different abnormal hemoglobin, "C,"** from the other, leads to this milder variant of SCD.
        - **HbS Beta Thalassemia:** This form arises from **inheriting an "S" gene from one**

parent and a beta thalassemia gene from the other.

- The severity varies based on the type of beta thalassemia inherited either **"zero" (HbS beta0) or "plus" (HbS beta+),** with the former typically resulting in a severe form and the latter in a milder manifestation.

- **Thalassaemia:** Similar to **sickle cell disease,** individuals with **thalassaemia experience severe anaemia due to low haemoglobin levels,** necessitating lifelong blood transfusions and **chelation therapy** to manage iron accumulation.
- Major symptoms include **fatigue, paleness or jaundice, shortness of breath, delayed growth, facial bone deformities (in severe cases)** among others.

Note

Chelation therapy is a proven treatment for **heavy metal poisoning**. It uses substances that bind to **heavy metals and help clear them from the body.**

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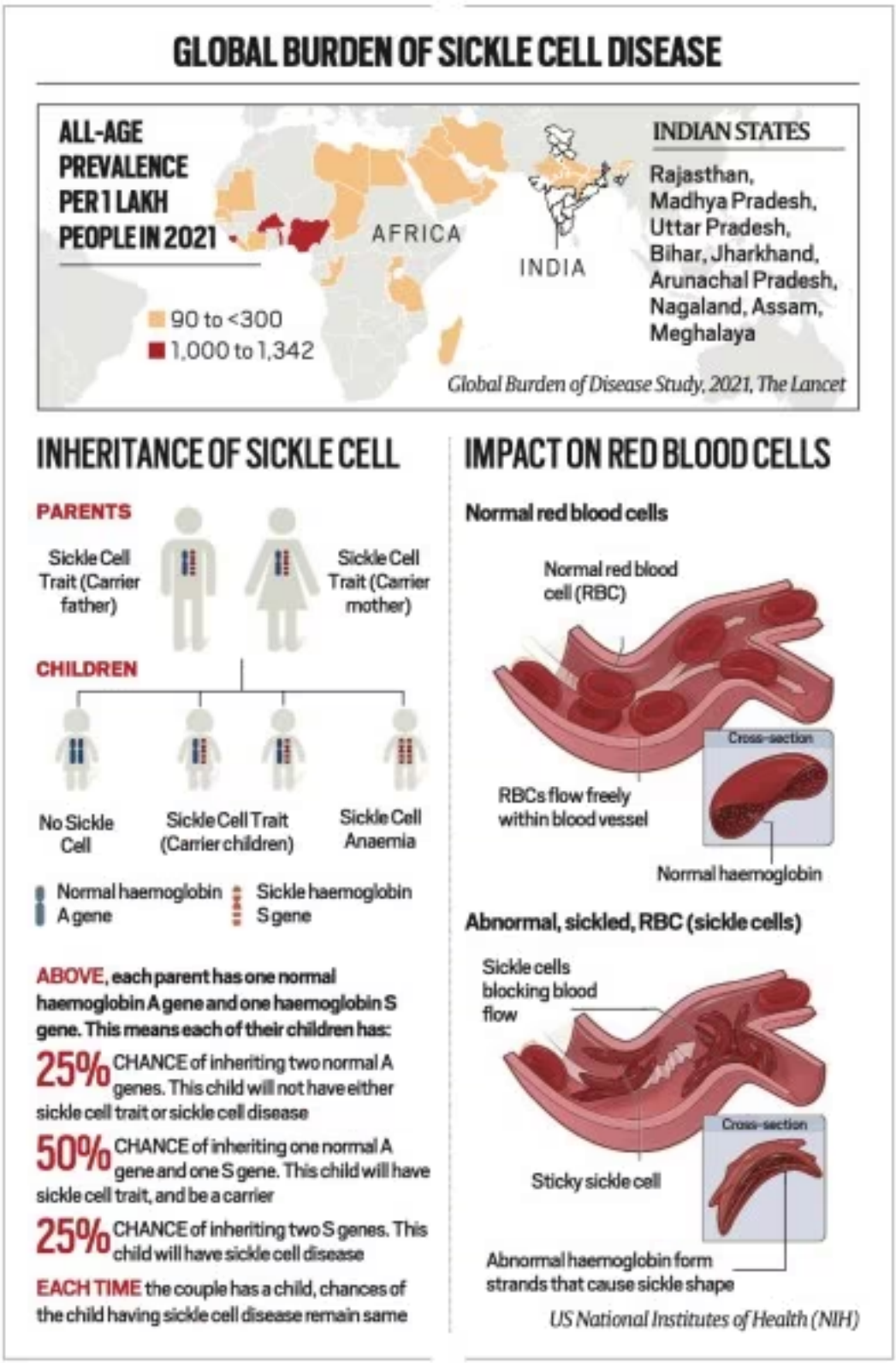

Note

The **National Sickle Cell Anemia Eradication Mission** in India targets the elimination of sickle cell anemia by 2047.

What is CRISPR-Cas9 Technology?

- **CRISPR-Cas9** is a groundbreaking technology that empowers geneticists and medical researchers to modify specific portions of the genome.

    - This is achieved through the **precise removal, addition, or modification of segments within the** DNA sequence.
- It involves two essential parts for editing DNA. First, there is **Cas9**, which acts like **molecular scissors,** cutting DNA at specific spots.
    - Then, there is **guide RNA (gRNA)**, containing a designed sequence. This sequence guides Cas9 to the exact spot in the genome to make the cut.
    - This **precise guidance ensures Cas9 works accurately where needed,** allowing for specific changes in the DNA.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. What is Cas9 protein that is often mentioned in news? (2019)

(a) A molecular scissors used in targeted gene editing
(b) A biosensor used in the accurate detection of pathogens in patients
(c) A gene that makes plants pest-resistant
(d) A herbicidal substance synthesized in genetically modified crops

Ans: (a)

Mains

Q. What are the research and developmental achievements in applied biotechnology? How will these achievements help to uplift the poorer sections of society? **(2021)**