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News: Xenotransplantation

- Recently, the first recipient of a modified pig kidney transplant passed away after his groundbreaking xenotransplantation surgery. His death was not linked to the transplant.

Xenotransplantation

- Xenotransplantation is any procedure that involves the transplantation, implantation or infusion into a human recipient of either live cells, tissues, or organs from a nonhuman animal source, or human body fluids, cells, tissues or organs that have had ex vivo contact with live nonhuman animal cells, tissues or organs.
- Purpose: The primary aim is to address the shortage of human donor organs.
- For instance, in the United States, nearly 90,000 people are waiting for a kidney transplant, with over 3,000 dying annually while still waiting.

Historical Context

- The practice dates back to the 1980s, with the heart being one of the first organs attempted for transplantation from animals to humans.

Procedure

- In xenotransplantation, the animal organ selected, such as a pig kidney, undergoes genetic modifications to improve its compatibility with the human body.
- This involves using gene-editing technologies like CRISPR-Cas9 to remove certain pig genes that produce sugars with antibodies our immune systems react to and adding human genes to improve the organ's compatibility.

Complications in Xenotransplantation

Organ Rejection

- Preventing the human body from rejecting the pig organ is a significant challenge. Techniques such as embedding the pig's thymus gland with the kidney help reduce immune responses.

Infection Risks

- The FDA highlights concerns about potential infections from both recognised and unknown infectious agents, which could spread to close contacts and the general population.

Retroviruses

- There is a **risk of cross-species infection by retroviruses**, which may remain latent and cause diseases years after infection.

Xenotransplantation in India

- In **1997**, a surgeon in Assam, performed a xenotransplantation procedure by **transplanting a pig's heart into a human patient**.
- Unfortunately, the **patient passed away a week later**, leading to **legal repercussions**.

Reasons for using Pigs most commonly

- **Historical Use:** **Pig heart valves have been used in human surgeries for over 50 years**.
- **Similarity to Humans:** **Pigs have anatomical and physiological similarities to humans**. Their widespread farming makes them a cost-effective and accessible source.
- **Size Matching:** **Various pig breeds offer a range of organ sizes, which can be matched to the specific needs of human recipients**.

CRISPR-Cas9

- CRISPR-Cas9 is a revolutionary technology that allows scientists to modify the genome by adding, removing, or altering sections of the Deoxyribonucleic Acid (DNA) sequence.
- It consists of two key molecules, an enzyme called Cas9, which acts as molecular scissors to cut the DNA, and a piece of RNA called guide RNA (gRNA) that guides Cas9 to the right part of the genome.
- The guide RNA is designed to bind to a specific sequence in the DNA, allowing the Cas9 enzyme to make a precise cut.
- This triggers the cell's DNA repair machinery, which can be used by scientists to introduce changes to the genes in the cell's genome.
- Emmanuelle Charpentier and Jennifer A. Doudna received the 2020 Nobel Prize in Chemistry for finding a powerful tool in gene technology called CRISPR/Cas9.