Xenotransplantation

Why in news?

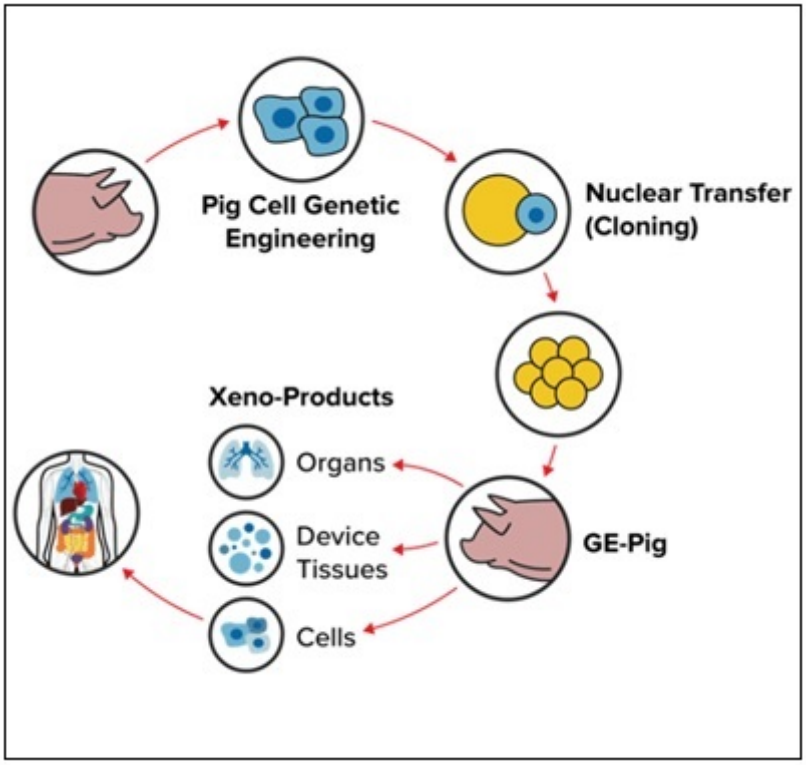
Recently, the first recipient of a modified pig kidney transplant passed away around two months after the surgery was carried out.

What is Xenotransplantation?

- **About**- It 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.

Xenotransplantation involving the heart was first tried in humans in the 1980s.

- **Cross species transplantation**-It is a process that involves the transplantation, implantation or infusion into a human recipient from a non-human animal source.



- **Genetic modification**- It is the critical step to reduce the likelihood of rejection of the animal organ by the human immune system.

Genetic editing	Genetic modification
It involves *making precise changes* to the DNA of an organism.	It is also known as *genetic engineering*, involves altering the genetic material of an organism by adding, deleting, or modifying genes.
Techniques like *CRISPR-Cas9, TALENs, and ZFNs* are commonly used for this purpose	Techniques like *recombinant DNA technology*, where DNA from different sources is combined, are often used.
It uses *engineered nucleases* to introduce cuts at specific locations in the DNA, these cuts are repaired by cell's natural repair mechanisms, which can result in the insertion, deletion, or replacement of DNA sequences	It can include the *introduction of new genes* from other species (transgenic modification), the deletion or silencing of genes, or the modification of existing genes
It specifically refers to *precise changes* at specific sites in the genome.	It is a *broader term* that includes any alteration of genetic material,
It is particularly useful for *correcting genetic defects* and studying specific genes.	It is commonly used to *introduce new traits* from other species.

Why pigs are focused on Xenotranspalnatation?

- **Anatomical similarity**- The pig's anatomical and physiological parameters are similar to that of humans organs in size and function.
- **Availability-**Pigs are widely bred on farms, making them an accessible and affordable source.
- **Variety of breeds**-Different pig breeds provide opportunities to match the size of harvested organs to human recipients' needs.
- **Proven track record**-Pig heart valves have been used to replace damaged human valves for *over 50 years*.

What is the significance of xenotransplantation?

- **Organ transplantation**- It is seen as an alternative to the clinical transplantation of human organs whose demand around the world exceeds supply by a long distance.
- **Reduce organ waiting list**- In human-human organ transplantation many people die while waiting to receive transplant from a human organ donor, Xenotransplantation shortens the organ waiting time.
- **Enhance longevity**- Xenotransplantation, if found compatible in the long run, could help provide an alternative supply of organs to those with life-threatening diseases.
- **Research on animals**- Scientists may save countless human lives by doing stem cell research on animals rather than human embryos.
- **Tissue transplants**- Along with cells and organs, tissues can also be transplanted into human bodies. These could include corneal transplants to encourage healthier vision and bone transplants.
- **Pattern of gene expression**- Continued research may reveal patterns of gene expression and antigen T-Cell response.
- **Valuable asset**- *Developmental biology* has been vital for human health and providing researchers with the tools they need will only help them make life better

- **Prevent black market**- The use of animal organs as an alternative could help to reduce the exploitative black market trade that sells human organs.

What are the challenges of xenotransplantation?

- **Zoonotic disease**- The main risk is transmission of animal viruses or diseases to humans, which could cause new pandemics.
- **Infection risk**- The risk of infection from an animal organ may be higher than the risk from a human organ as the animal organ may contain animal-specific germs.
- **Organ farming**- Animal rights would be violated and humans may begin the practice of "organ farming".
- **Genetic manipulation**- Further research may lead to genetic manipulation.
- **Organ rejection**- Another challenge is the rejection of animal organs by the human immune system, which could lead to organ failure or inflammation.
- **Ethical concerns**- Some people criticize xenotransplantation because of religious beliefs, such as that mixing species is against God's will.
- **Constant monitoring**- Post-surgery, patients require continuous monitoring to check the body's response to the transplanted organ.
- **Less longevity**- The animal organs does not last for long period in human bodies as their average life expectancy is less than human.
    - Example- The average life expectancy of pigs is *15 to 20 years* whereas for humans it is around *72 years*.

What lies ahead?

- Xenotransplantation holds promise for addressing the shortage of human donor organs, but it requires overcoming significant medical and ethical challenges.
- Worldwide harmonization of regulatory guidelines for oversight is needed to address the infectious risks associated with xenotransplantation.
- Genetic modifications, infection risks, and immune response management are critical areas needing continuous research and development.
- Despite the hurdles, the progress in xenotransplantation offers hope for patients awaiting transplants and could eventually provide a viable solution to the organ shortage crisis.

References

1. Indian Express- Pig kidney transplant dies
2. Indian Express- What is Xenotransplantation