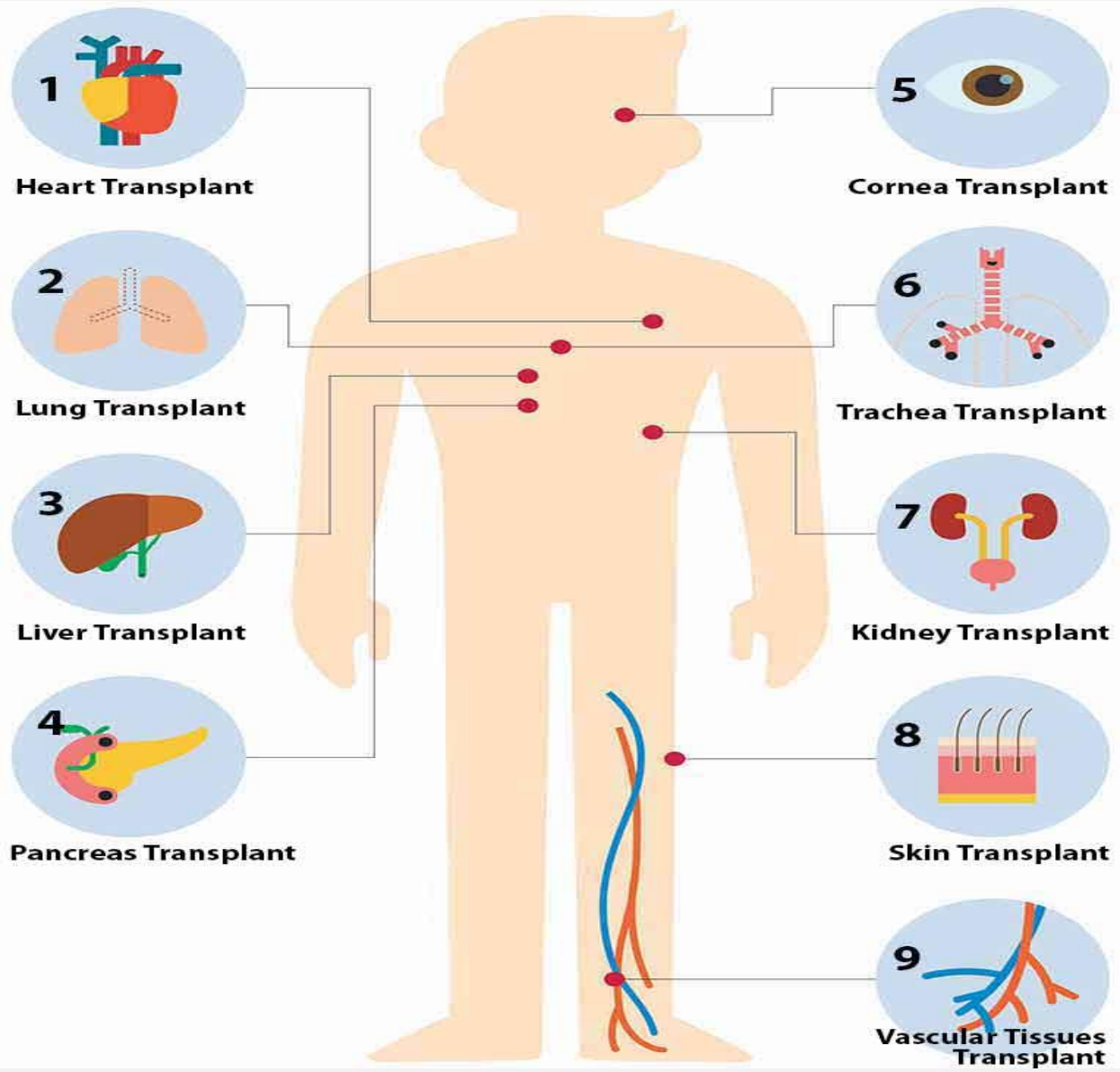
ORGAN TRANSPLANTATION

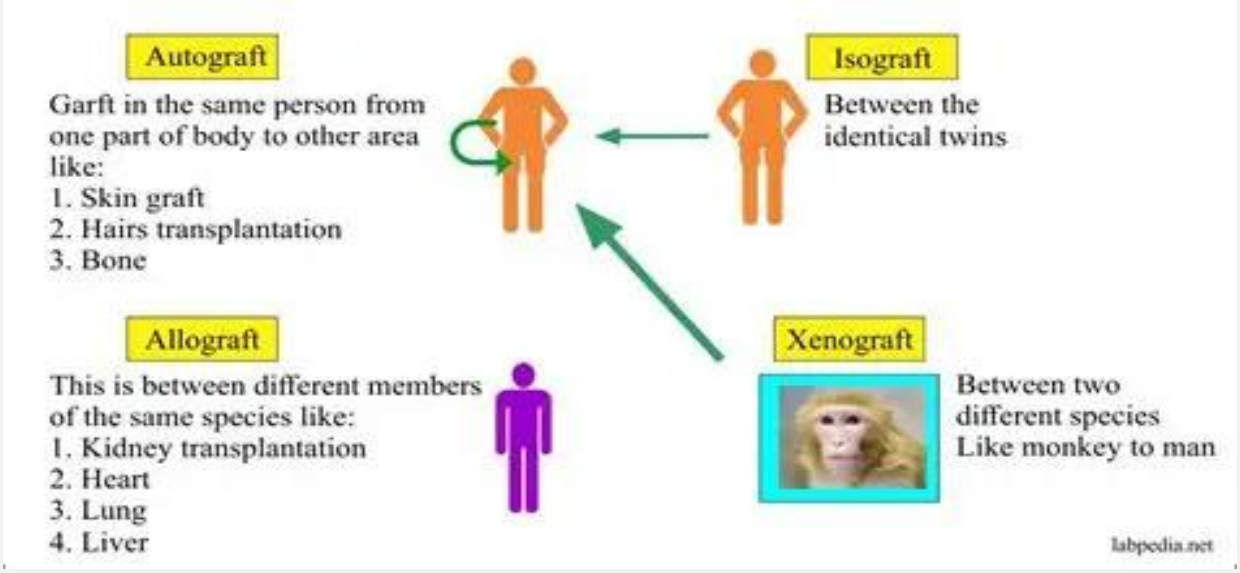
1. Introduction

- **Organ transplantation** is the **surgical transfer of an organ or tissue** from one person (the **donor**) to another (the **recipient**) to replace a **damaged or non-functioning organ**.
- It is a **life-saving procedure** used for end-stage organ failure.
- Successful transplantation depends on **tissue compatibility** and **control of immune rejection**.



2. Basic Definitions

Term	Meaning
Donor	The individual providing the organ or tissue
Recipient	The individual receiving the transplant
Autograft	Transplantation within the same individual (e.g., skin graft)
Isograft (Syngeneic graft)	Between genetically identical individuals (e.g., identical twins)
Allograft (Homograft)	Between genetically different individuals of the same species (e.g., human → human)
Xenograft (Heterograft)	Between different species (e.g., pig → human)



3. Commonly Transplanted Organs and Tissues

Organ / Tissue	Indication for Transplant
Kidney	Chronic renal failure (most common transplant)
Liver	Cirrhosis, hepatitis, metabolic diseases
Heart	End-stage heart failure
Lungs	COPD, pulmonary fibrosis
Pancreas	Type I diabetes mellitus
Cornea	Corneal opacity or keratoconus
Bone marrow / Stem cells	Leukemia, aplastic anemia, immunodeficiency
Skin	Burns, trauma

4. Types of Donors

Type	Description
Living donor	Donates one kidney, part of liver, or bone marrow
Deceased donor (cadaveric donor)	Organs retrieved after brain death or cardiac death
Paired donation	Exchange between incompatible donor-recipient pairs
Xenogenic donor	From animals (experimental)

5. Criteria for Organ Donation

A. Brain Death Criteria (for deceased donors):

- Irreversible loss of brain function, including brainstem.
- Absence of:
    - Brainstem reflexes
    - Spontaneous breathing (apnea test)
- Confirmed by two independent physicians.

B. Legal and Ethical Considerations

- Informed consent required (from donor or family).
- Governed by national laws (e.g., **Transplantation of Human Organs and Tissues Act, 1994** in India).
- Commercial organ trade is **illegal**.

6. Immunological Basis of Transplantation

A. Major Histocompatibility Complex (MHC)

- **MHC (HLA in humans)** determines tissue compatibility.
- **HLA matching** between donor and recipient is crucial to reduce rejection.
- **Classes of HLA:**
    - **Class I (A, B, C):** Present on all nucleated cells.
    - **Class II (DR, DQ, DP):** Present on antigen-presenting cells.

B. Blood Group Compatibility

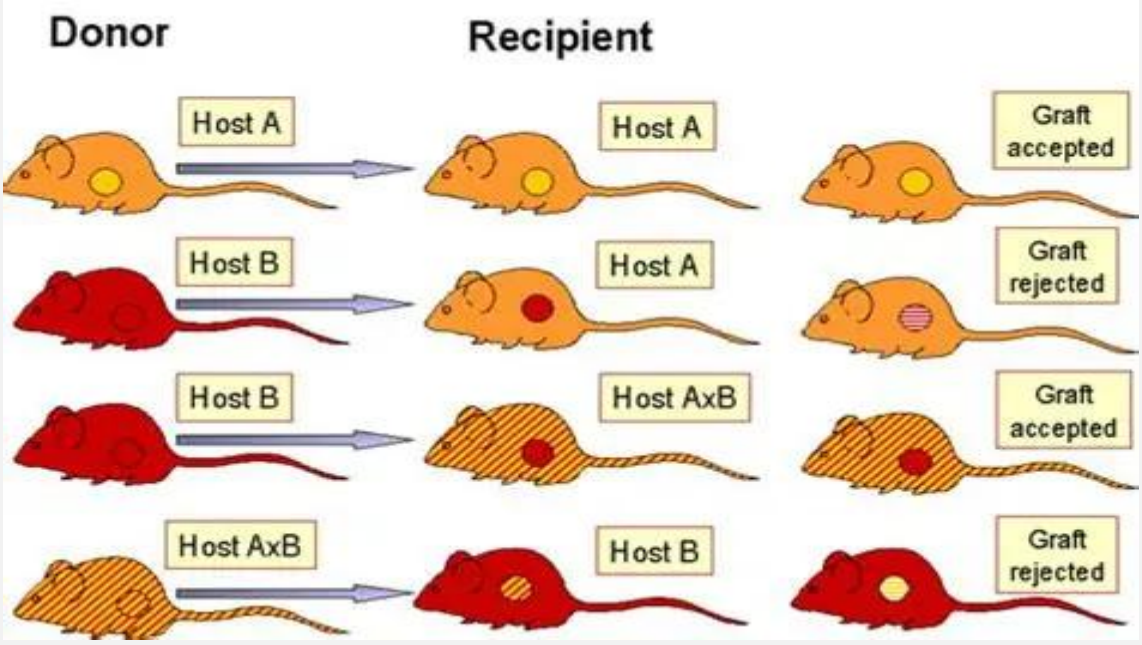
- **ABO blood typing** must match between donor and recipient to prevent hyperacute rejection.

7. Graft Rejection

Rejection occurs when the **recipient's immune system recognizes the donor organ as "foreign"** and attacks it.

Types of Graft Rejection:

Type	Time of Onset	Mechanism	Features
1. Hyperacute rejection	Minutes to hours	Pre-existing antibodies (Type II hypersensitivity)	Immediate graft failure; thrombosis, necrosis
2. Acute rejection	Days to weeks	T cell-mediated and antibody-mediated	Fever, graft tenderness, organ dysfunction
3. Chronic rejection	Months to years	T cell-mediated inflammation and fibrosis	Progressive loss of graft function, fibrosis, vascular thickening



Mechanism of Rejection (Simplified)

1. **Recognition:** Recipient T cells recognize donor MHC as foreign.
2. **Activation:** Helper T cells release cytokines.
3. **Attack:** Cytotoxic T cells and antibodies destroy graft cells.
4. **Inflammation and fibrosis** lead to graft failure.

8. Prevention and Management of Rejection

A. Pre-Transplant Compatibility Testing

- **ABO typing**
- **HLA typing**
- **Cross-match test** (checks for preformed antibodies in recipient's serum)

B. Immunosuppressive Therapy (Post-Transplant)

Drug Class	Mechanism	Examples
Corticosteroids	Inhibit cytokine production	Prednisolone
Calcineurin inhibitors	Inhibit T cell activation	Cyclosporine, Tacrolimus
Antiproliferative agents	Block lymphocyte proliferation	Azathioprine, Mycophenolate mofetil
mTOR inhibitors	Inhibit cell cycle progression	Sirolimus, Everolimus
Monoclonal antibodies	Block T cell surface antigens	Basiliximab, Muromonab-CD3
Polyclonal antibodies	Deplete T cells	Antithymocyte globulin (ATG)

Goal: Prevent rejection while minimizing infection and drug toxicity.

9. Complications of Organ Transplantation

Category	Examples
Immunological	Rejection (hyperacute, acute, chronic)
Infectious	Opportunistic infections due to immunosuppression
Metabolic	Hypertension, diabetes, renal toxicity
Neoplastic	Post-transplant lymphoproliferative disorder (PTLD)
Surgical	Bleeding, thrombosis, anastomotic leaks

10. Special Transplant Types

A. Bone Marrow / Hematopoietic Stem Cell Transplant

- Used in leukemia, lymphoma, aplastic anemia.
- Requires **HLA-matched donor**.
- Major complication: **Graft-versus-Host Disease (GVHD)**
    - **Donor T cells attack recipient tissues** (skin, liver, gut).

B. Corneal Transplant (Keratoplasty)

- Immune-privileged site → high success rate.
- Does not require HLA matching.

C. Xenotransplantation

- Use of animal organs (e.g., pig heart).
- Experimental; risk of severe immune rejection and viral transmission.

11. Organ Preservation and Transport

Method	Organ	Temperature / Medium	Storage Time
Cold ischemic storage	Most organs	0–4°C	Varies
Kidney	Perfused with preservation solution (e.g., UW solution)	Up to 48 hours	
Liver / Heart	Cold perfusion	4–6 hours	
Lung	Perfused with low-potassium dextran	6 hours	
Cornea	Stored in corneal storage medium	7–10 days	