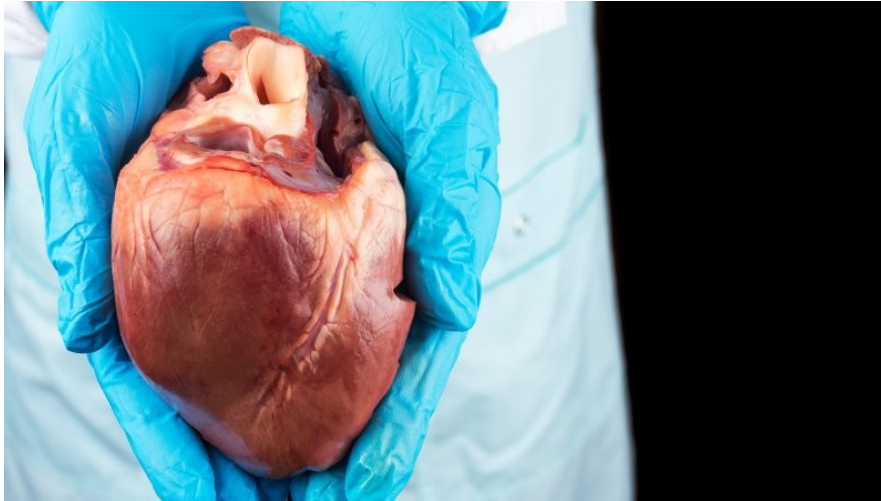


# TRANSPLANT SURGERY



Department of Trauma Surgery  
University Hospital Brno

## DEFINITION :

An organ transplant is a surgical operation in which a failure or damaged organ in human body is removed and replaced with a functioning one. The donated organ may be from a deceased donor, a living donor or an animal.

- ▶ Organs that can be transplanted are the heart, kidneys, liver, lungs, pancreas, intestine and thymus.
- ▶ Tissues include bones, tendons, cornea, skin, heart valves, nerves and veins.
- ▶ Worldwide, the kidneys are the most commonly transplanted organs, followed by the liver and then the heart.

## Types of transplants

*Autograft*

*Allograft*

*Isograft*

*Xenograft*

*Split transplant*

*Domino transplant*

**Autograft** is a transplant of tissue from one to oneself. Sometimes this is done with surplus tissue, or tissue that can regenerate, or tissues more desperately needed elsewhere (examples include skin grafts, for CABG, etc.) sometimes this is done to remove the tissue and then treat it or the person before returning it.

**Allograft** is transplant of an organ or tissue between two genetically non identical members of the same species. Most human tissue and organ transplants are allografts.

**Isograft** - a sub set of allografts in which organs or tissues are transplanted from a donor to a genetically identical recipient (such as an identical twin). Isografts are differentiated from other types of transplants because while they are anatomically identical to allografts, they do not trigger an immune response.

**Xenograft** - A transplant of organs or tissue from one species to another. Xenograft is often an extremely dangerous type of transplant because of increased risk of noncompatibility, rejection, and disease carried in the tissue. Examples include porcine heart valves, which are quite common and successful. The latter's research study directed for potential human use if successful.

**Split transplants** - sometimes, a deceased-donor organ, usually a liver, may be divided between two recipients, especially an adult and a child. This is not usually a preferred option because the transplantation of a whole organ is more successful.

**Domino transplants** - This operation is usually performed for cystic fibrosis as both lungs need to be replaced and it is a technically easier operation to replace the heart and lungs. As the recipient's native heart is usually healthy, this can then itself be transplanted into someone needing a heart transplant

# Major organs and tissues transplanted

## CHEST:

Heart (deceased-donor only)

Lung (deceased-donor and living-donor)

Heart/Lung (deceased-donor and domino transplant)

## ABDOMEN:

Kidney (deceased-donor and living-donor)

Liver (deceased-donor and living-donor)

Pancreas (deceased-donor only)

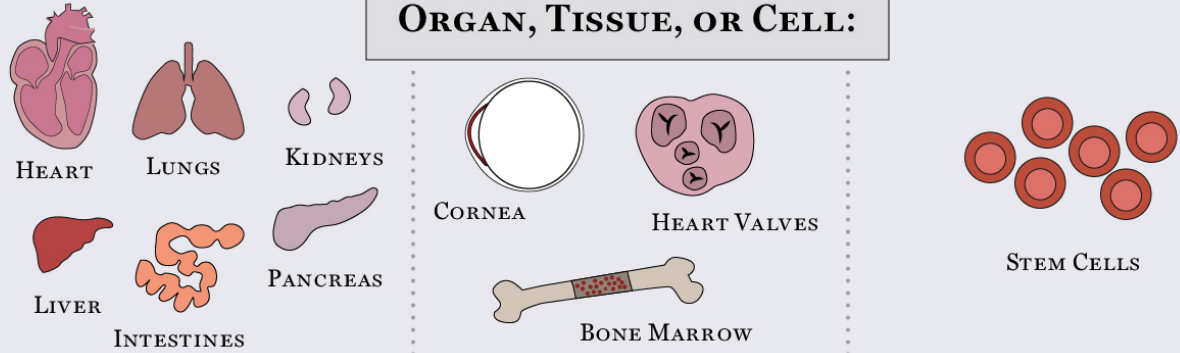
Intestine (deceased-donor and living-donor)

Stomach (deceased-donor only)

Testis (deceased-donor and living-donor)

# THE MANY COMPONENTS OF ORGAN TRANSPLANTATION

## ORGAN, TISSUE, OR CELL:



## NONSELF

## TRANSPLANT:

## FOREIGN ANTIGENS



RECOGNITION? TOLERANCE? ACCEPTANCE?

## SELF (HOST IMMUNE SYSTEM)



## *ADAPTIVE IMMUNITY*

## *INNATE IMMUNITY*

## REJECTION:

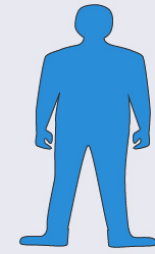
HYPERACUTE, ACUTE, OR CHRONIC



**GRAFT VS HOST**  
*DONOR CELLS REJECT RECIPIENT CELLS*



*RECIPIENT CELLS REJECT DONOR CELLS*



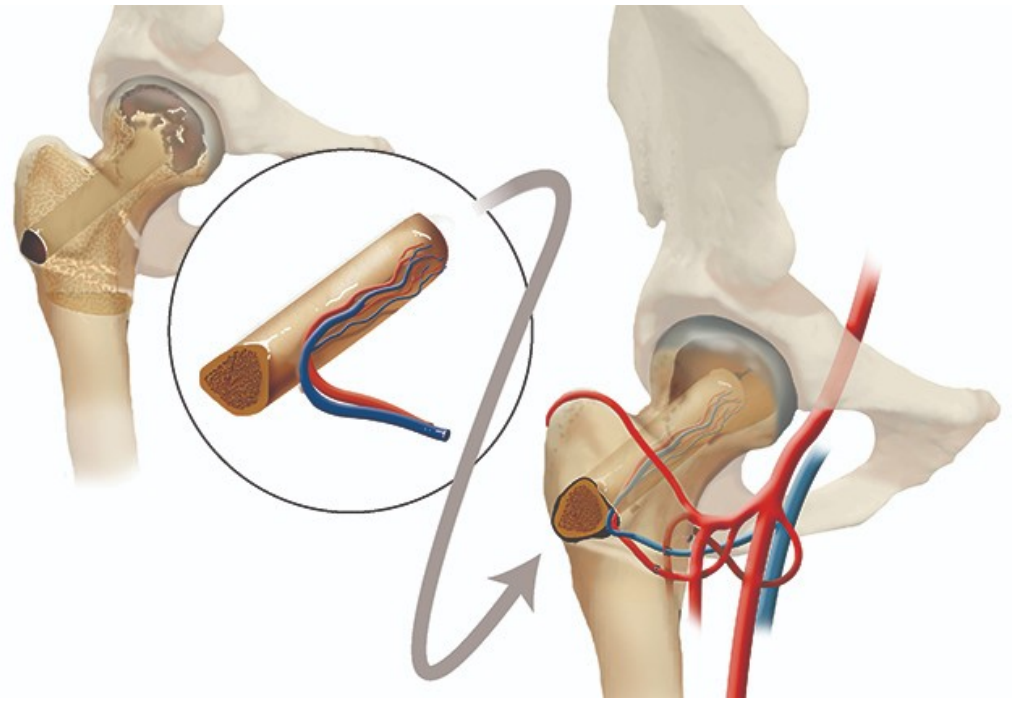
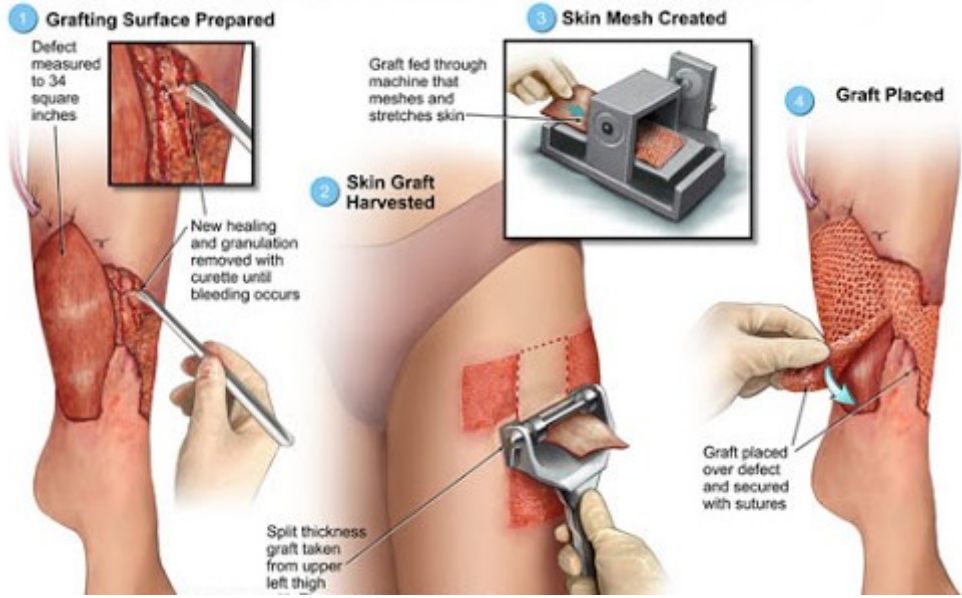
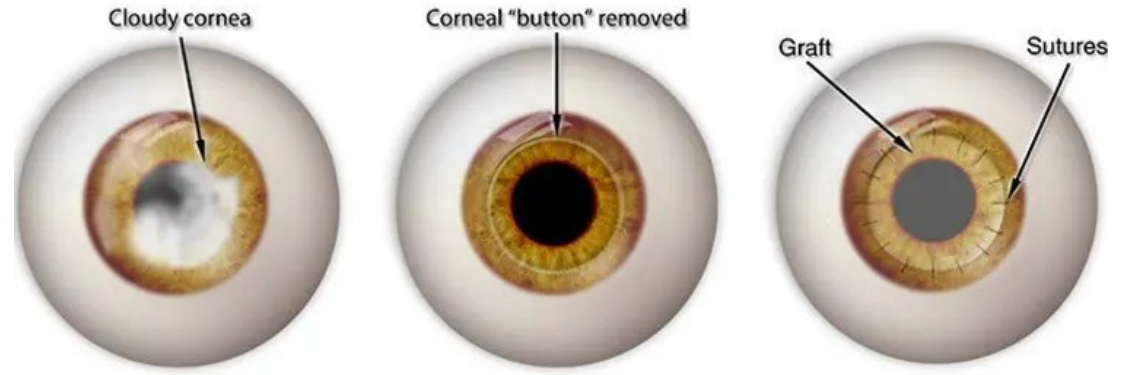
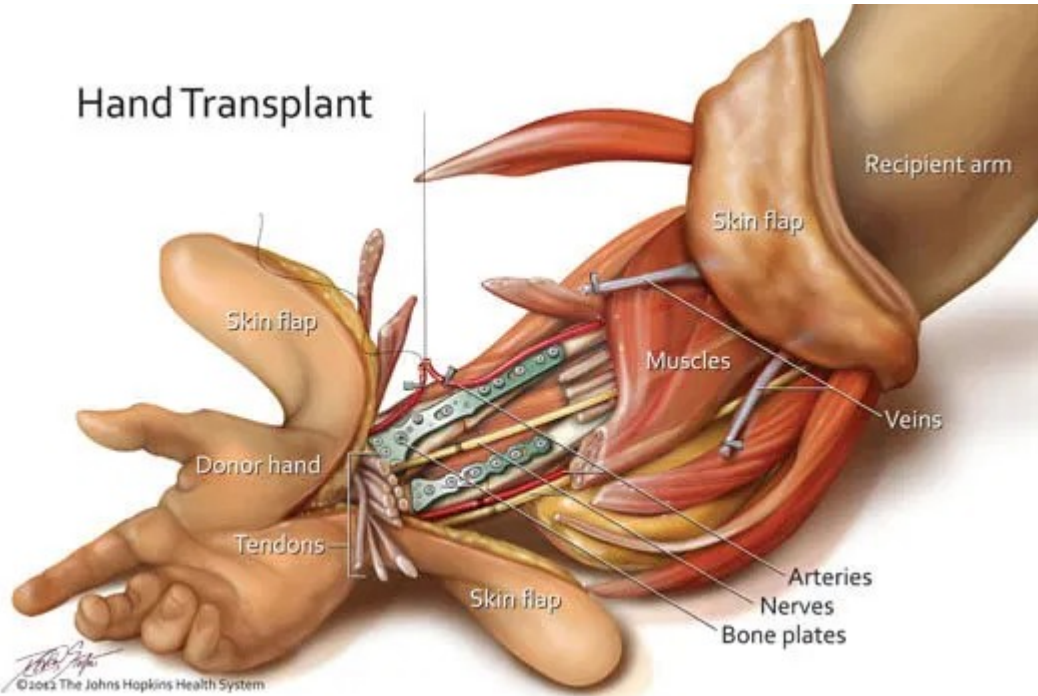
**HOST VS GRAFT**

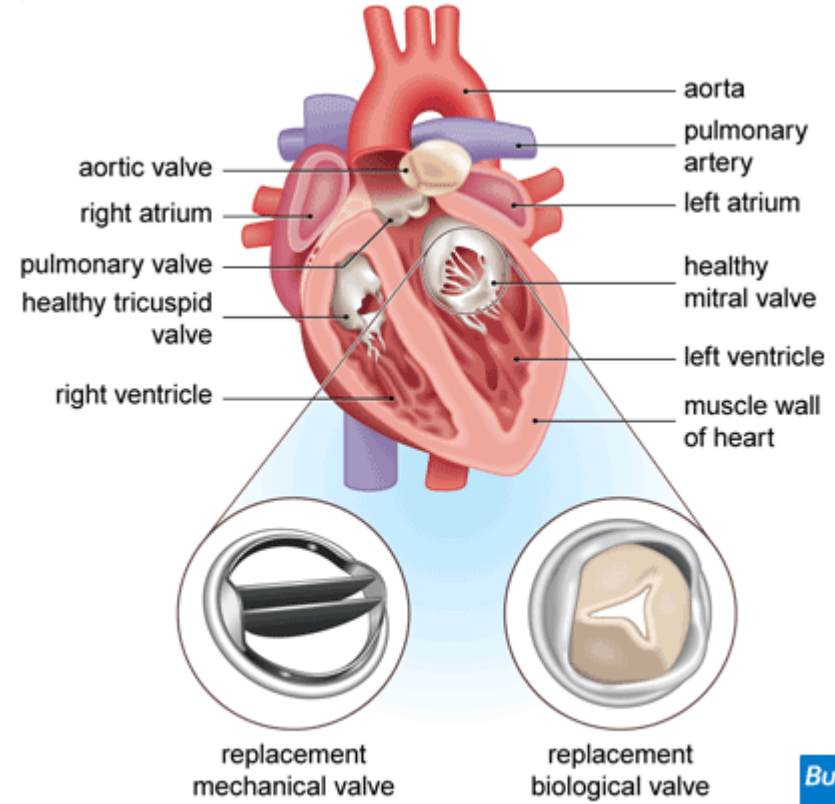
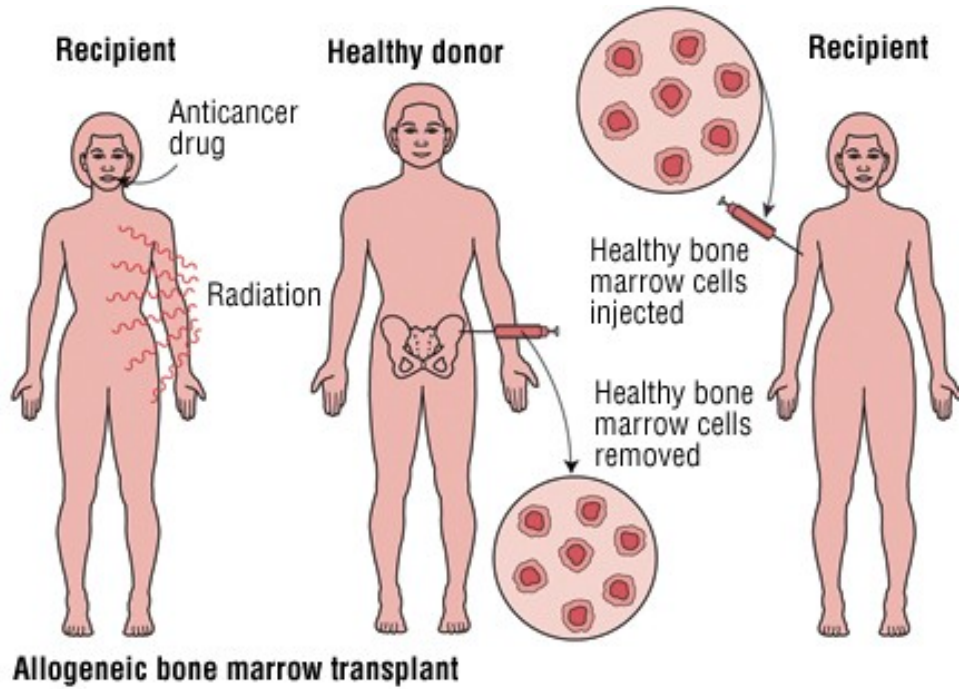
# Tissues, cells and fluids

- Hand (deceased-donor only)
- Cornea (deceased-donor only)
- Skin (deceased-donor, living-donor and autograft)
- Islets of langerhans (deceased-donor and livingdonor)
- Bone marrow (living-donor and autograft)
- Heart valves (deceased-donor, living-donor and xenograft)
- Bone (deceased-donor, living-donor and autograft)



# Hand Transplant





**The types of heart valve replacement**



# Transplant antigens

## Human leucocytes antigen(HLA)

- a group of highly polymorphic cell surface molecules
- They act as antigen recognition unit on T lymphocytes and are the major trigger for graft rejection
- Types; class1 –A,B,C present in all nucleated cells, class2 – HLADR, DP,DQ present only on APC
- Class 2- HLA-DR are most important in rejection
- CD8+ and CD4+ recognize class 1 and 2 receptors respectively

## **MHC**

Major histocompatibility complex. They are clusters of genes on the short arm of chromosome 6 expressed on the cell surface as HLA i.e. genes that encode HLA.

## **ABO**

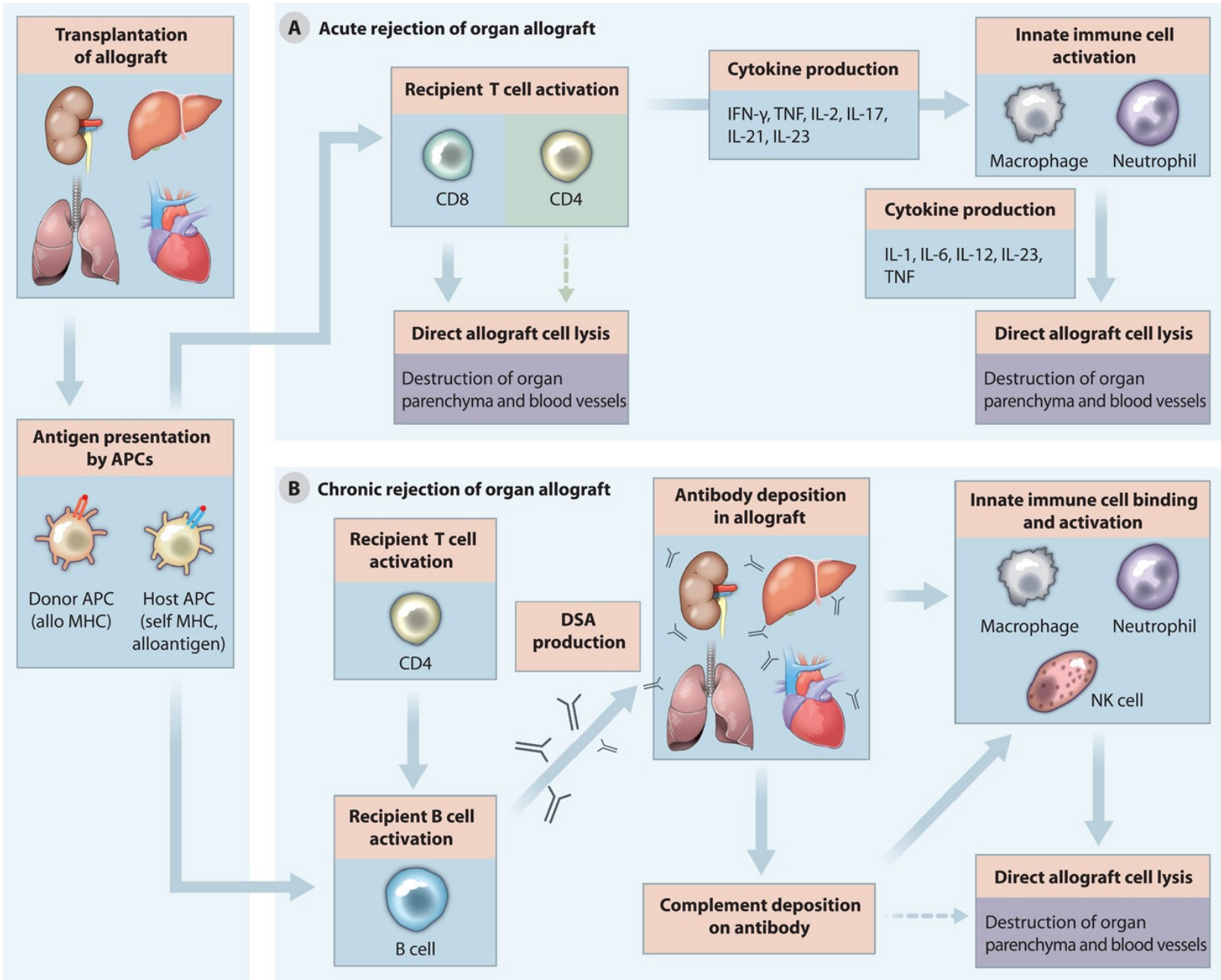
These blood group antigen are expressed not only on red blood cells but by most cell types as well. Incompatibility leads to hyperacute rejection.

## GRAFT REJECTION

Rejection of transplanted organs is a bigger challenge than the technical expertise required to perform the surgery. It results mainly from HLA and ABO incompatibility.

- **Hyperacute**
- **Acute**
- **Chronic**





## Hyperacute rejection

- Immediate graft destruction due to AB or preformed anti- HLA antibodies.
- Characterized by intravenous thrombosis and interstitial hemorrhage. Risk factors are previous failed transplant and blood transfusions
- Kidney transplant is vulnerable to hyperacute rejection

## Acute rejection

- Usually occurs during the first 6month
- May be cell mediated (T-cell), antibody mediated or both
- Characterized by cellular infiltration of the graft(cytotoxic, B- cells, NK cells and macrophages)

- **Chronic rejection**

- It occurs after 6month
- Most common cause of graft failure
- Antibodies play important role
- Non- immunological factors contribute to the pathogenesis
- Characterized by myointimal proliferation in graft arteries leading to ischemia and fibrosis



## • **PATIENT SELECTION AND EVALUATION**

### RECIPIENT

➤ Patient who met the indication for transplant –

### ORGAN FAILURE

- Clinical evaluation; history and physical examination to rule out other diseases and comorbidities
- Immunological evaluation
- Serology; HIV, Hepatitis, CMV, VDRL
- Tissue typing & cross matching
- Blood group
- Infection screening – septic work-up, mantoux
- Others ; FBC, clotting profile, FBS, ECG, U/Ecr, tumour markers, stool microscopy

## Patient selection

- DONOR

## Cadaveric

Individuals with severe brain injury resulting in brain death-Brain death is defined as “complete irreversible cessation of all brain functions”

Other criteria;

- Normothermic patient.
- No respiratory effort by the patient.
- The heart is still beating.
- No depressant drugs intake should be there while evaluating the patient.
- Individual should not have any sepsis, cancer (except brain tumour).
- Not a HIV or hepatitis individual.

## Living donor

a living donor should be healthy

Living unrelated donor or

Living related donor

- Improved graft survival
- Less recipient morbidity
- Early function and easier to manage
- Avoidance long waiting time for transplant
- Less aggressive immunosuppressive regimen

# Contra-indications for living donor

- Mental disease
- Disease organ
- Morbidity and mortality risk
- ABO incompatibility
- Crossmatching incompatibility
- Transmissible disease

## **Evaluation -to assess for suitability**

- CLINICAL - history of risk factors for infection, malignancy in the past 5 years. Presence of co-morbidities
- ABO typing.
- Serology tests.
- Infection and malignant screening
- CT-Angiogram
- Intravenous urography.
- HLA typing.

# **FACTORS DETERMINING ORGAN FUNCTION AFTER TRANSPLANT**

## **DONOR CHARACTERISTICS**

- Extremes of age
- Presence of pre-existing disease in the transplanted organ
- Haemodynamic and metabolic instability

## **PROCUREMENT-RELATED FACTORS**

- Warm ischaemic time
- Type of preservation solution
- Cold ischaemic time

## **RECIPIENT-RELATED FACTORS**

- Technical factors relating to implantation
- Haemodynamic and metabolic stability
- Immunological factors
- Presence of drugs that impair transplant function

## COUNSELING

- May involve professional counselors/ psychotherapist
- Aimed at preventing / minimizing possible complication
- Need for adherence to post-op maintenance medications
- Regular follow-up thorough evaluation
- Life style modification; smoking, alcohol, sedentary life style, junks, excessive salt ingestion.

## DECEASE DONOR

- Some Factors influencing refusal to consent by relatives;
  - non-acceptance of brain death.
  - Superstitions relating to being reborn with a missing organ
  - A delay in funeral
  - Lack of consensus within family members
  - Fear of social criticism
  - Dissatisfaction with the hospital staff
  - Religious believes

## LIVING DONOR

- Education
- Willingly not for any financial reason or under duress
- Most undergo extensive screening – medical phycological
- Involve family
- Surgery and anaesthetic complications complications outline to patients



## RECIPIENT

Nature of disease and the need for transplant

Outcome and complications

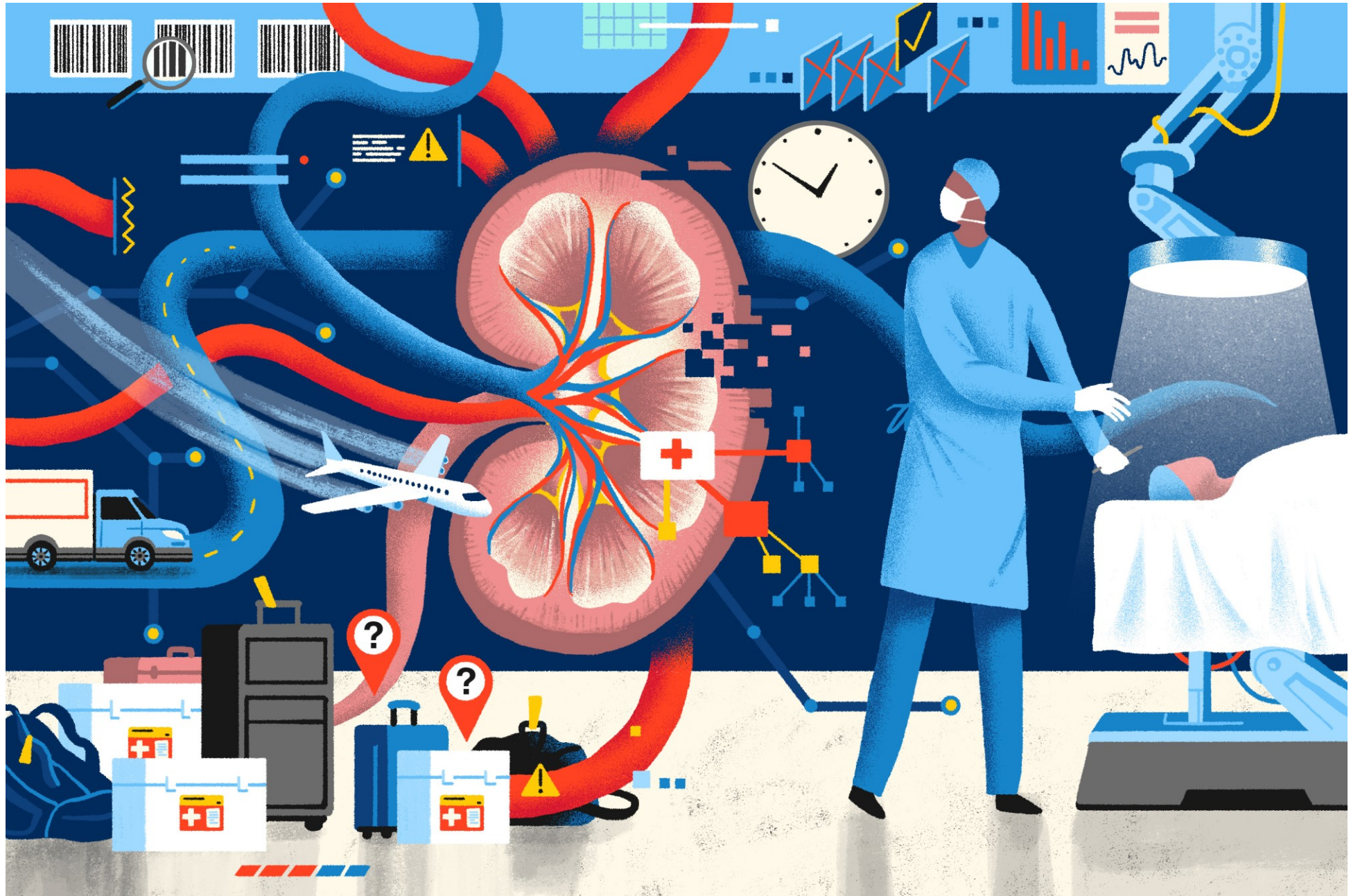
Need for compliance to immunosuppressive therapy

Other available options

## OPTIMIZATION OF RECIPIENT

Correction of derangements, getting patient ready for surgery

- Correction of anaemia
- Uremia
- Dehydration
- Treatment of infection
- Treatment of malaria
- Deworming of patient
- Central line
- Urethral catheter
- Loading dose immunosuppression 12hr pre-op
- Prophylactic antibiotics



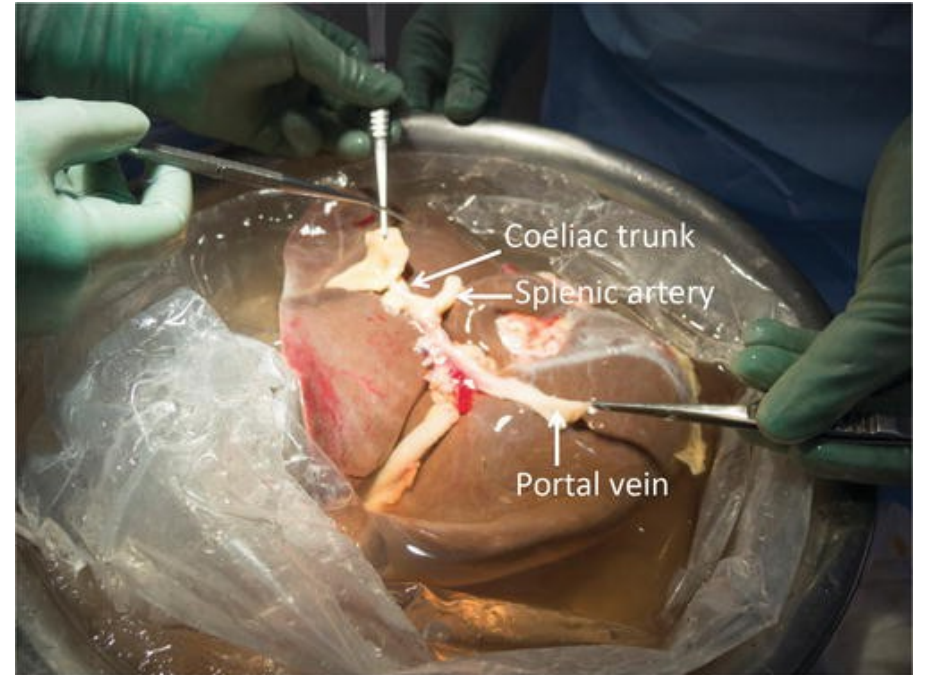
## PRINCIPLES

### INTRA-OPERATIVE

Organ procurement and preservation

*Living donors*

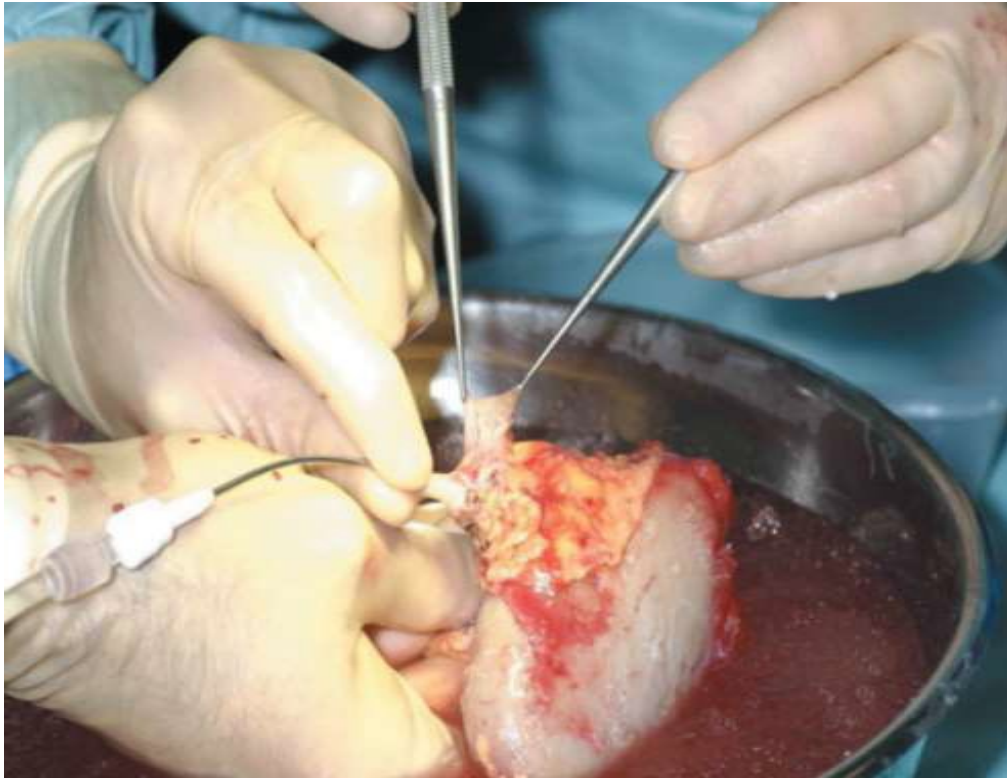
- a.** Strict asepsis and hemostasis
- b.** Adequate exposure
- c.** Control of the vessels above and below the organs to be removed is done- cross clamping
- d.** Removal of the organ





## e. Preservation

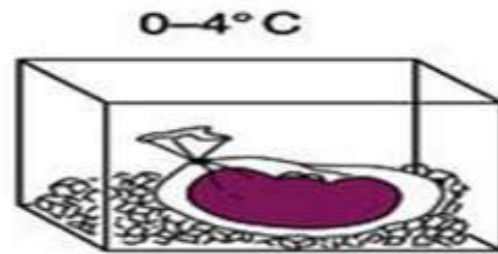
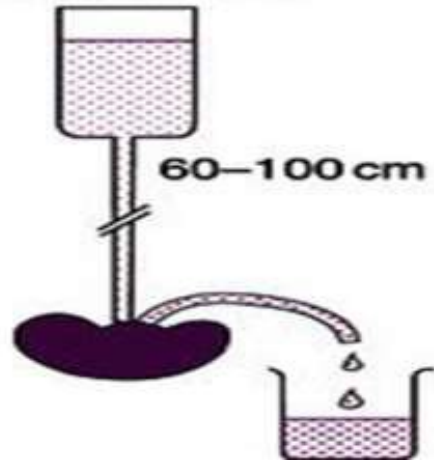
After removal, the organ is flushed with chilled organ preservation solution e.g. – University of Wisconsin (UW), Eurocolins, Celsior, Citrate/Marshall solutions



## g. Organ packing

(a)

Flush out blood  
cold storage solution  
cool to 0–4°C



## **h. Transplantation/vascular reconstruction**

***Warm ischemic time*** ; time an organ remains at *body temperature* between which the blood supply is cut off before cold perfusion. (within 30min)

***Cold ischemic time*** ; the time between the chilling of the organ, after blood supply has been cut off and the time it is warmed by reconnection

## Warm and Cold ischemic time

Organ	warm	Cold
kidney	30 min	Up to 48 hr
Heart	0	Up to 4 hr
Heart/lung	0	Up to 4 hr
Lung	0	Up to 4 hr
Liver	0	Up to 18 hr
Small bowel	0	As soon as possible
pancreas	0	Up to 12 hr



# PRINCIPLES

## Post-operative

### Post-operative assessment

**Clinical** –vital signs; *fever, tachycardia, hypertension*, pain at site of transplant, pedal oedema (compression of external iliac vein), decrease urine volume- ***features of hyperacute rejection***

### Investigations

#### U/Ecr

**USS**- increase in size, pelvicalyceal dilation

**Biopsy**; *mononuclear infiltrates, fibrinoid necrosis, interstitial haemorrhage.*

## Others

- Maintenance immunosuppression
- DVT prophylaxis
- Treatment of infection
- Regular follow up

## IMMUNOSUPPRESSION

- The principles are the same for type of organ transplant; ***maximize graft protection and minimize side effect.***
- The agents used to **prevent rejection** act predominantly on **T cells**.
- The need for immunosuppression is highest in the first 3 months but indefinite treatment is needed
- It increases the risk of infection and malignancy.

# COMPLICATIONS OF IMMUNOSUPPRESSION

## INFECTIONS

high risk of **opportunistic** infections

**Bacterial**; common during first month after transplantation / before recovery from surgery

- Community acquired infections
- Wound infection
- UTI (catheter related)
- Tuberculosis

**Viral** ; highest in the first six month

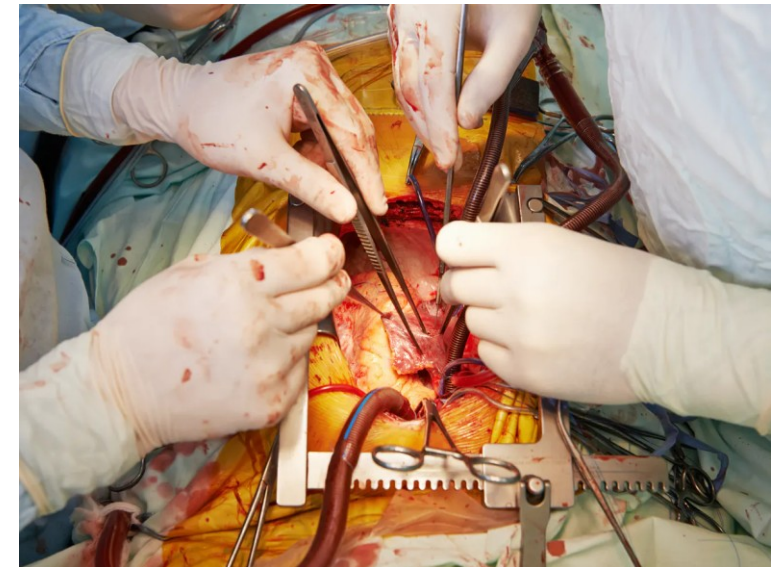
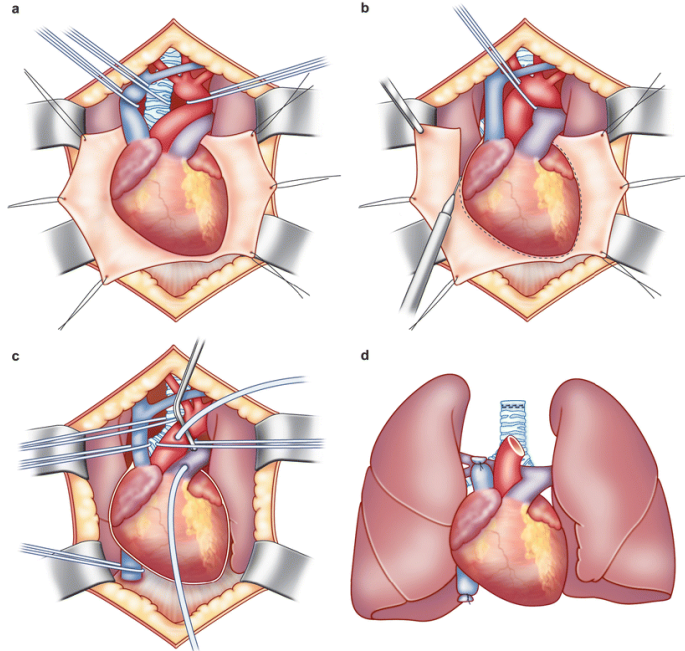
- **CMV** infection; may presents as *pnuemonia, gastrointestinal disease, hepatitis, retinitis, encephalitis*
- **Herpes simplex virus (HSV)** ; mucocuteneous lesions sometimes around the genitalia
- **BK-virus**; graft dysfunction
- **Herpes zoster infection**; chicken pox
- **Fungal** ; pneumocystic jiroveci(carinii), candidiasis, aspergillosis
- **Parasitic**; strongiloides, leimaniasis, toxoplasmosis

# MALIGNANCY

- **Post transplant lymphoproliferative disease (PTLPD)**; seen 1-3% of kidney transplant with 50% mortality
- **Squamous cell ca** of the skin
- Basal cell ca and malignant melanoma are higher in transplant patient than the general population
- 50% of transplant patient would develop skin malignancy in 20years
- **Kaposi sarcoma**; 300 fold increased risk

# • Heart transplantation

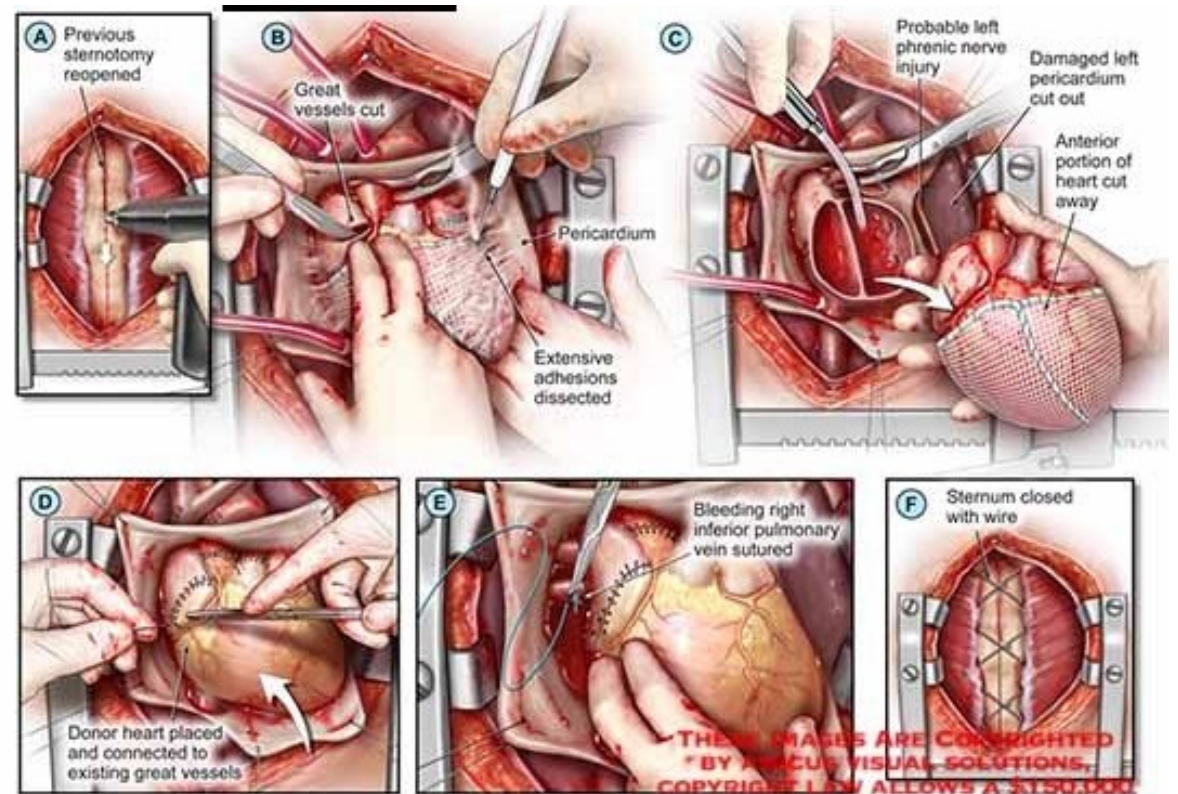
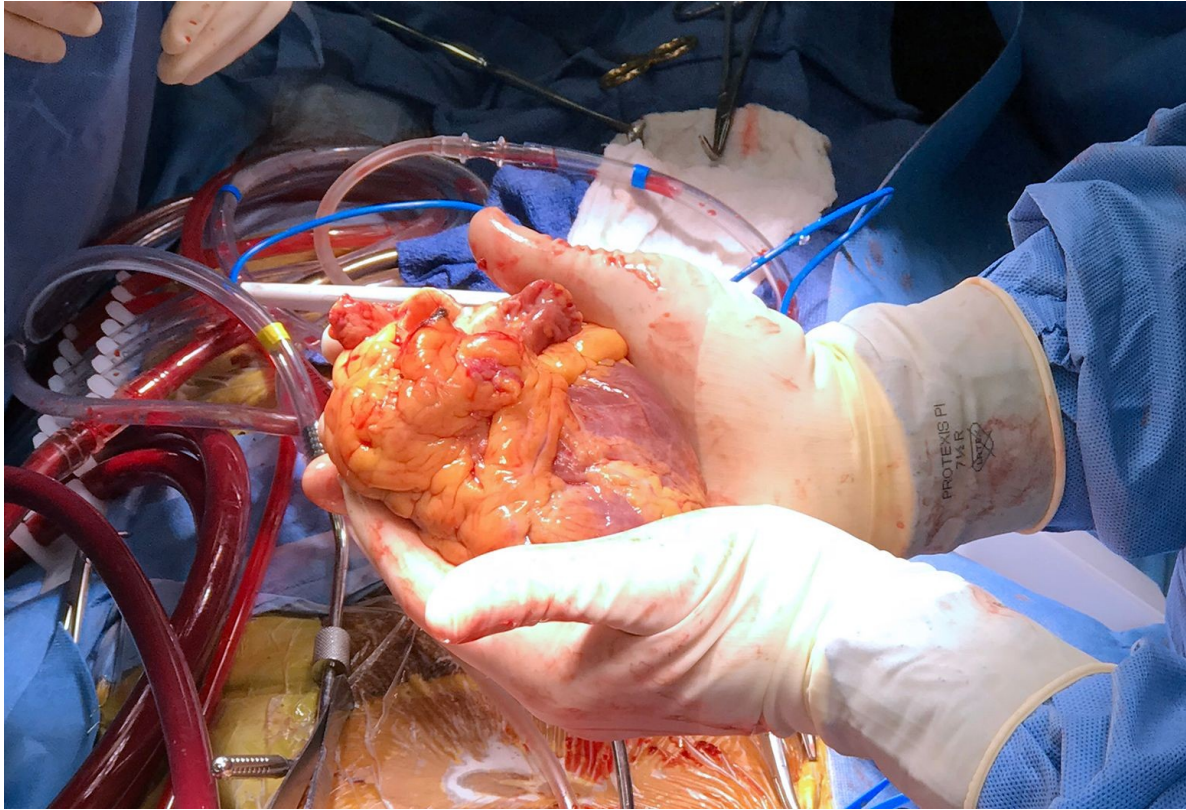
- A heart transplant is an operation in which a diseased, failing heart is replaced with a healthier donor heart. Heart transplant is a treatment that's usually reserved for people whose condition hasn't improved enough with medications or other surgeries.



- Heart transplants are performed when other treatments for heart problems haven't worked, leading to heart failure. In adults, heart failure can be caused by:
  - A weakening of the heart muscle (cardiomyopathy)
  - Coronary artery disease
  - Heart valve disease
  - A heart problem you're born with (congenital heart defect)
  - Dangerous recurring abnormal heart rhythms (ventricular arrhythmias) not controlled by other treatments
  - Failure of a previous heart transplant
- In children, heart failure is most often caused by either a congenital heart defect or cardiomyopathy.

- Another organ transplant may be performed at the same time as a heart transplant (multiorgan transplant) in people with certain conditions at select medical centers.
- Multiorgan transplants include:
- **Heart-kidney transplant.** This procedure may be an option for some people with kidney failure in addition to heart failure.
- **Heart-liver transplant.** This procedure may be an option for people with certain liver and heart conditions.
- **Heart-lung transplant.** Rarely, doctors may suggest this procedure for some people with severe lung and heart diseases if the conditions cannot be treated with only a heart transplant or a lung transplant.





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### Absolute contraindications:

Advanced [kidney](#), [lung](#), or [liver](#) disease

Active cancer if it is likely to impact the survival of the patient

Life-threatening diseases unrelated to the cause of [heart failure](#), including acute infection or systemic disease such as [systemic lupus erythematosus](#), [sarcoidosis](#) or [amyloidosis](#)

[Vascular disease](#) of the neck and leg arteries.

High pulmonary vascular resistance – over 5 or 6 [Wood units](#).

### Relative contraindications:

[Insulin](#)-dependent [diabetes](#) with severe organ dysfunction

Recent [thromboembolism](#) such as [stroke](#)

Severe obesity

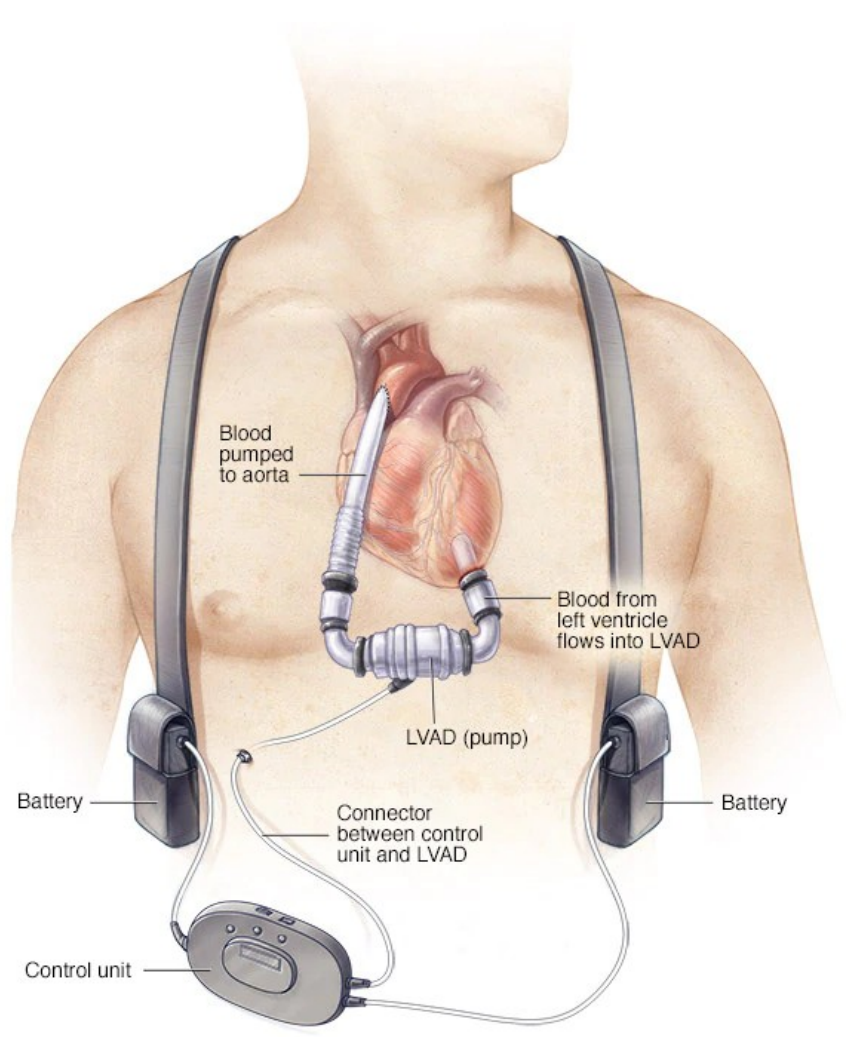
Age over 65 years (some variation between centers) – older patients are usually evaluated on an individual basis.

Active substance abuse, such as alcohol, recreational drugs or [tobacco](#) smoking (which increases the chance of lung disease)

## Ventricular assist devices

- For some people who cannot have a heart transplant, another option may be a ventricular assist device (VAD). A ventricular assist device is a mechanical pump implanted in your chest that helps pump blood from the lower chambers of your heart (ventricles) to the rest of your body.
- VADs are commonly used as temporary treatments for people waiting for heart transplants. These devices are increasingly being used as long-term treatments for people who have heart failure but are not eligible for heart transplants. If a VAD doesn't help your heart, doctors may sometimes consider a total artificial heart — a device that replaces the ventricles of your heart — as an alternative short-term treatment while you're waiting for a heart transplant





- **Risks**

- Besides the risks of having open-heart surgery, which include bleeding, infection and blood clots, risks of a heart transplant include:
  - Rejection of the donor heart. One of the most significant risks after a heart transplant is body rejecting the donor heart.
  - Primary graft failure. With this condition, the most frequent cause of death in the first few months after transplant, the donor heart doesn't function.
  - Problems with arteries. After transplant, it's possible that the walls of the arteries in heart could thicken and harden, leading to cardiac allograft vasculopathy. This can make blood circulation through your heart difficult and can cause a heart attack, heart failure, heart arrhythmias or sudden cardiac death.
  - Medication side effects. The immunosuppressants taken for the rest of your life can cause serious kidney damage and other problems.
  - Cancer. Immunosuppressants can also increase the risk of developing cancer. Taking these medications can put patient at a greater risk of skin and lip tumors and non-Hodgkin's lymphoma, among others.
  - Infection. Immunosuppressants decrease ability to fight infection. Many people who have heart transplants have an infection that requires them to be admitted to the hospital in the first year after their transplant.

# KIDNEY TRANSPLANT

A kidney transplant is a surgical procedure to place a healthy kidney from a living or deceased donor into a person whose kidneys no longer function properly

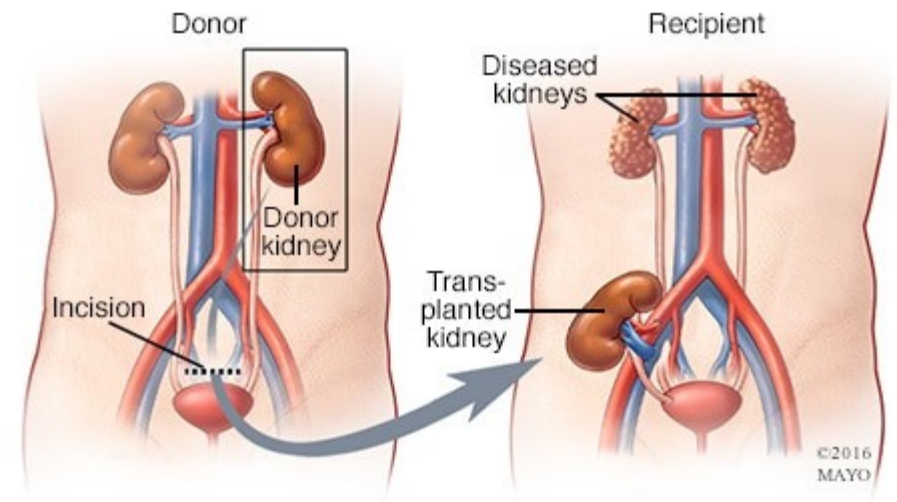
## ○ **Indications**

### ○ ***End-stage renal disease***

#### ***Causes***

- glomerulonephritis;
- diabetic nephropathy;
- hypertensive nephrosclerosis;
- renal vascular disease;
- polycystic disease;
- pyelonephritis;
- obstructive uropathy;
- systemic lupus erythematosus;
- analgesic nephropathy;
- metabolic disease (oxalosis, amyloid).

- A kidney transplant is often the treatment of choice for kidney failure, compared with a lifetime on dialysis. A kidney transplant can treat chronic kidney disease or end-stage renal disease to help you feel better and live longer.
- Compared with dialysis, kidney transplant is associated with:
  - Better quality of life
  - Lower risk of death
  - Fewer dietary restrictions
  - Lower treatment cost





## Donor Nephrectomy

- Open or laparoscopic
- Open donor nephrectomy is the gold standard
- Open donor nephrectomy is via the 12<sup>th</sup> rib incision, and in fat patient 10<sup>th</sup> rib or hypogastrium
- **Extraperitoneal** : avoid devascularizing ureter, sharp dissection, avoid diathermy near vessels
- Renal vasculature dissect flush to IVC/Aorta
- Ligate lumbar veins posteriorly ± gonadal vein

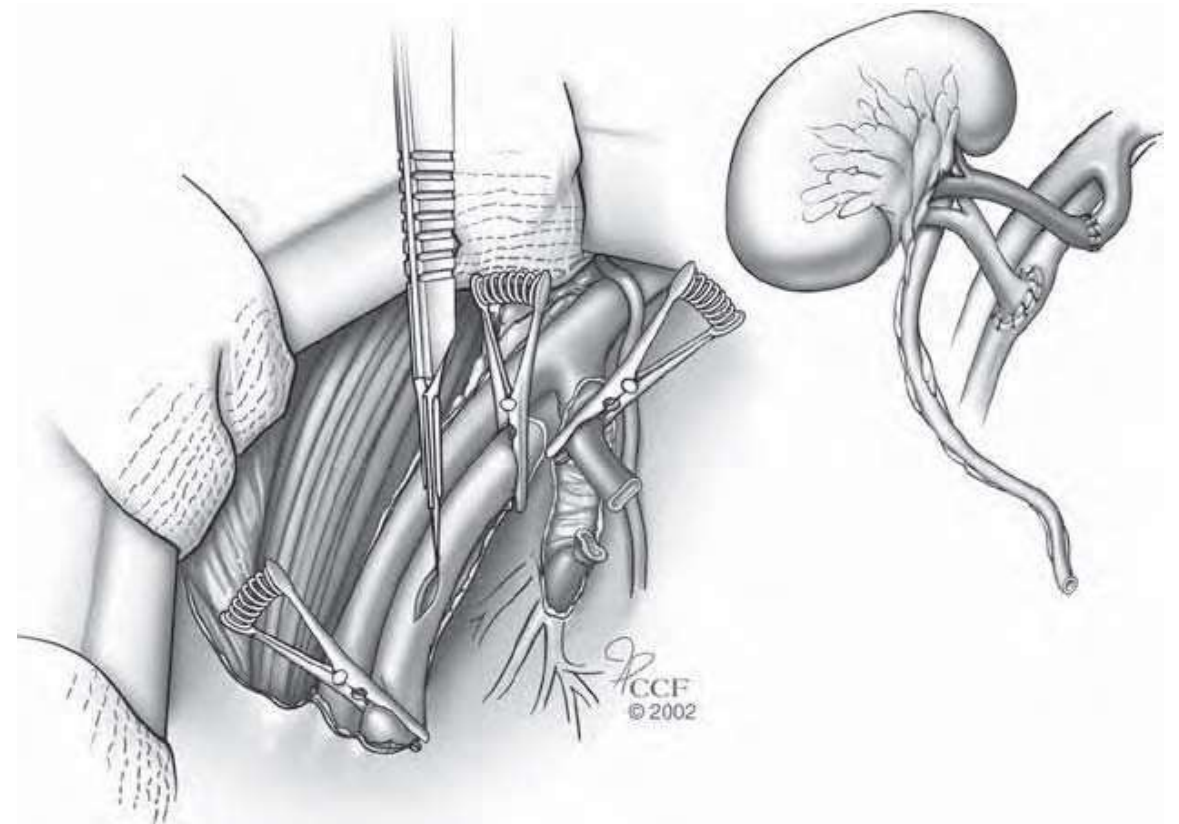
# Donor Kidney Bench Surgery

- The kidney is perfused with ice-cold preservative
- Iced saline is mashed into a slush and kidney immersed
- Extra veins ligated, accessory artery(ies) anastomosed together
- Kidney now ready for transplanting



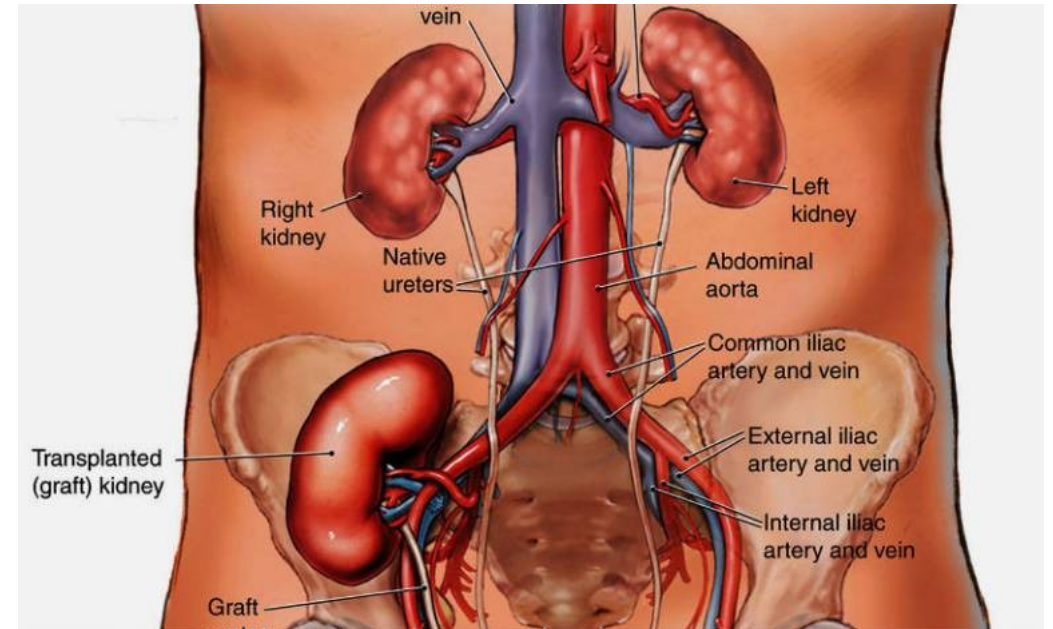
## THE TRANSPLANT

- Right donor kidney to left recipient site and vice versa
- **Gibson's incision**; Curvilinear incision 2 cm above the inguinal ligament, from midline to just above the anterior Sup. Iliac Spine
- End to side venous anastamosis 5/0 prolene
- End to end arterial anastamosis 5/0 Prolene
- Implant ureter to bladder



# COMPLICATIONS

- TECHNICAL
- **Vascular hemorrhage**; Vascular thrombosis 10-20%, within 2-3 days → technical, 2/12 → rejection, most are lost: ↓urine output, ↑creat
- **Urological** ; infection, fistula, obstruction
- **Wound infection**
- RENAL
- Acute tubula necrosis
- Cortical necrosis
- Lymphocele
- Graft rupture
- Recurrent glomerulo-nephritis



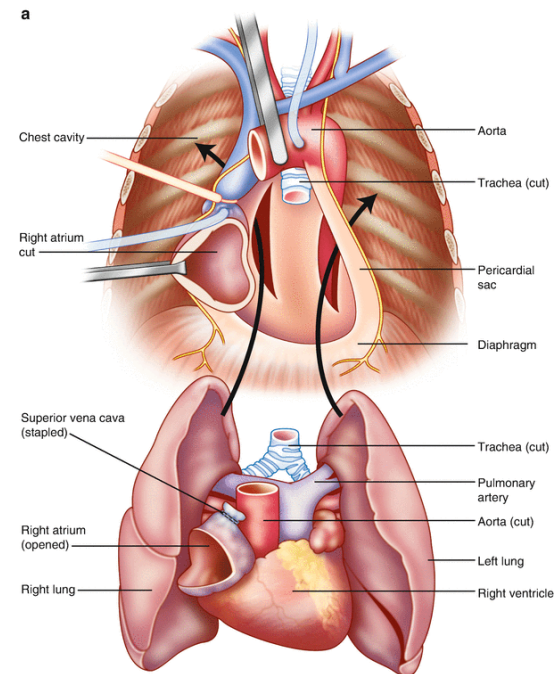
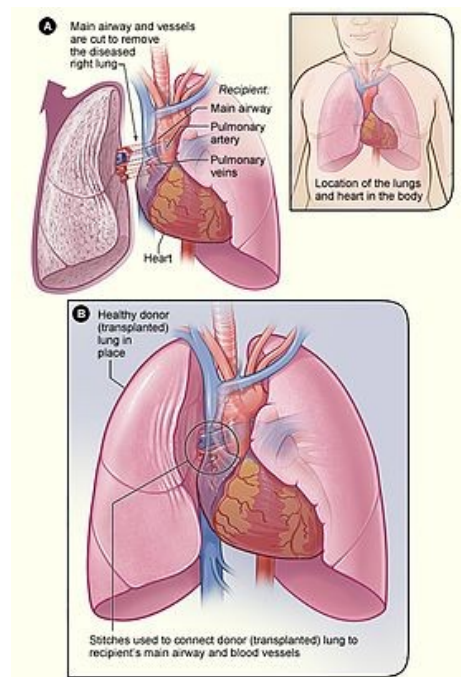
# • Outcome

- ○ Patient survival after deceased donor renal transplantation is >90% at 1 year and > 80% at 5 years.
- ○ Graft survival is around 90% at 1 year and 75% at 5 years. Graft survival after a second transplant is only marginally worse than after a first graft.
- ○ After living-related kidney transplantation, overall graft survival is around 95% at 1 year and 85% at 5 years.

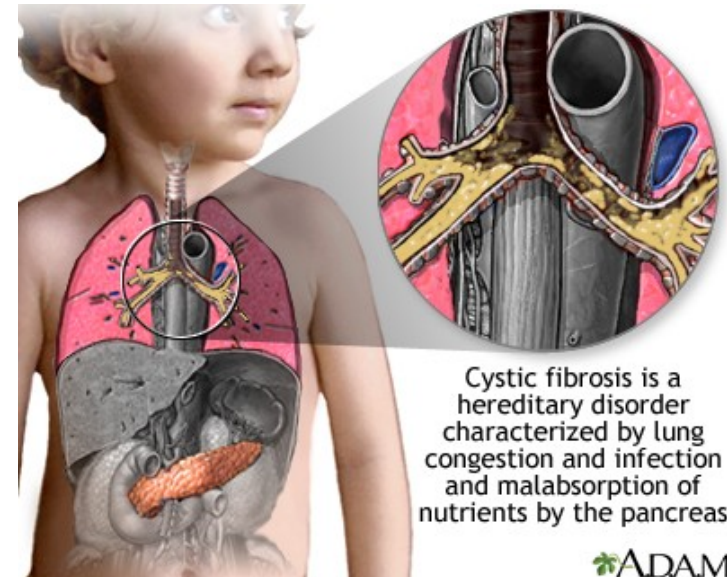


# • Lung Transplantation

- Lung transplantation, or pulmonary transplantation, is a surgical procedure in which a patient's diseased lungs are partially or totally replaced by lungs which come from a donor. Donor lungs can be retrieved from a living donor or a deceased donor. A living donor can only donate one lung lobe. With some lung diseases, a recipient may only need to receive a single lung. With other lung diseases such as cystic fibrosis, it is imperative that a recipient receive two lungs. While lung transplants carry certain associated risks, they can also extend life expectancy and enhance the quality of life for end-stage pulmonary patients.

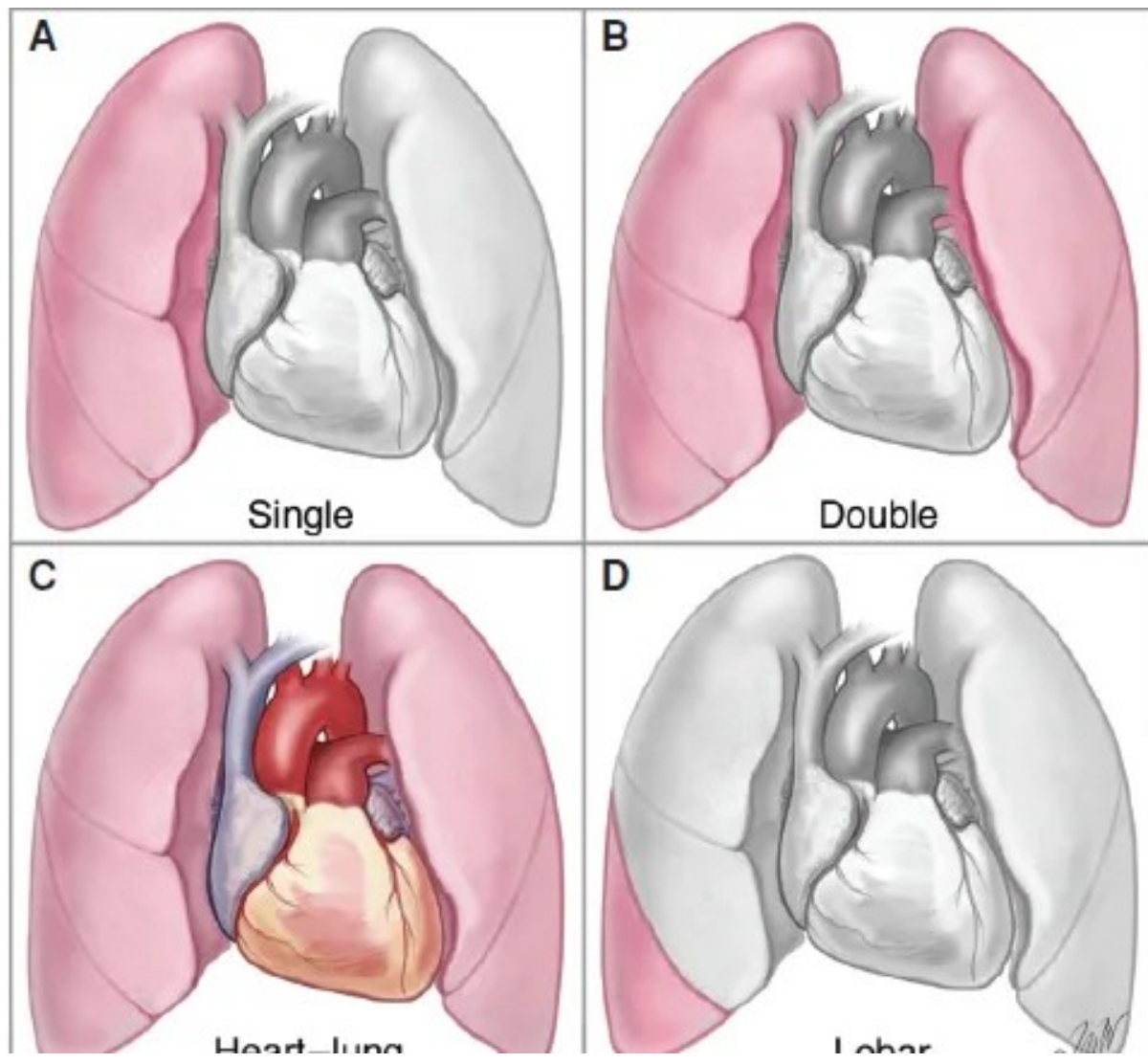


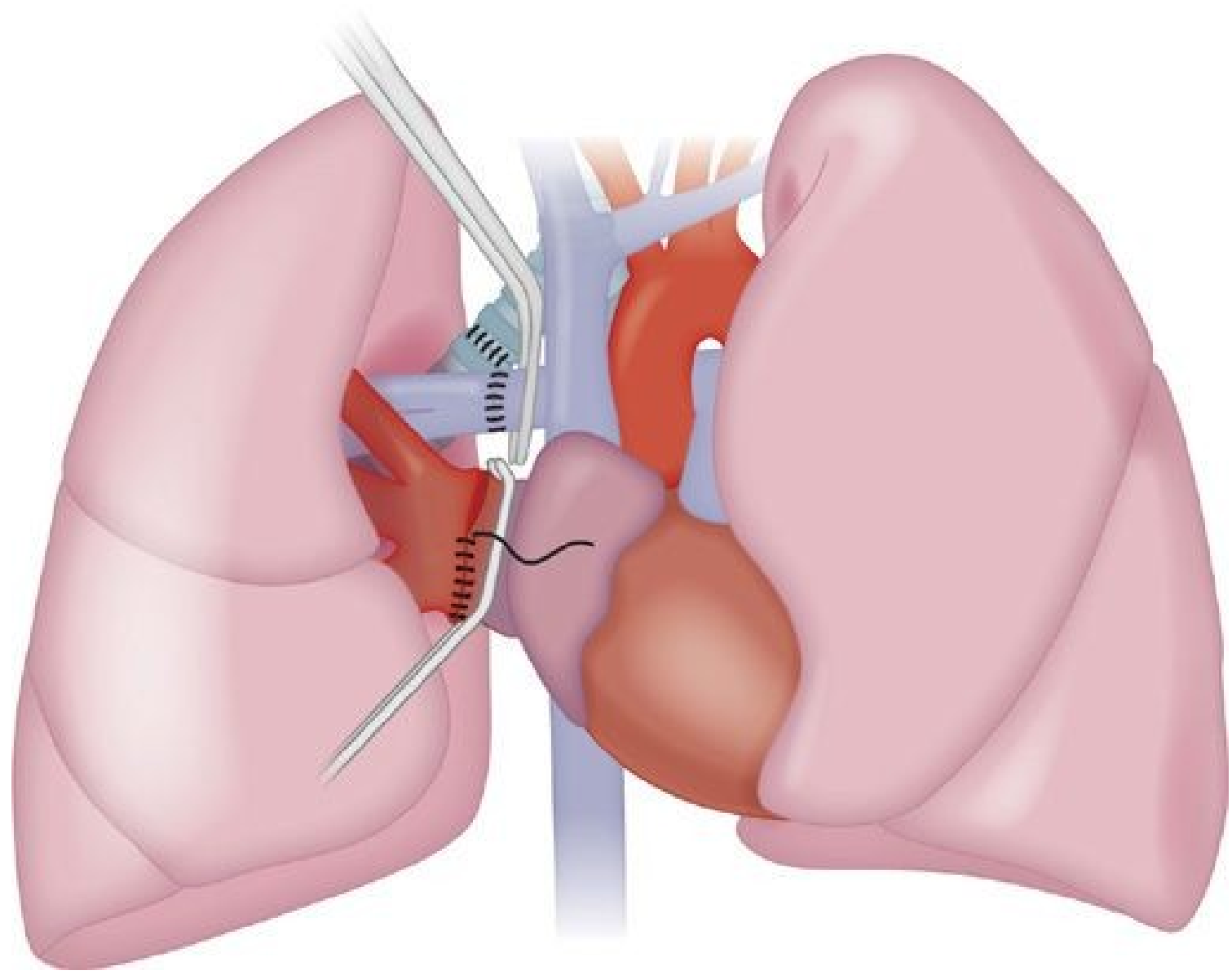
- Unhealthy or damaged lungs can make it difficult for your body to get the oxygen it needs to survive. A variety of diseases and conditions can damage your lungs and hinder their ability to function effectively. Some of the more common causes include:
- *Chronic obstructive pulmonary disease (COPD), including emphysema*
- *Scarring of the lungs (pulmonary fibrosis)*
- *High blood pressure in the lungs (pulmonary hypertension)*
- *Cystic fibrosis*

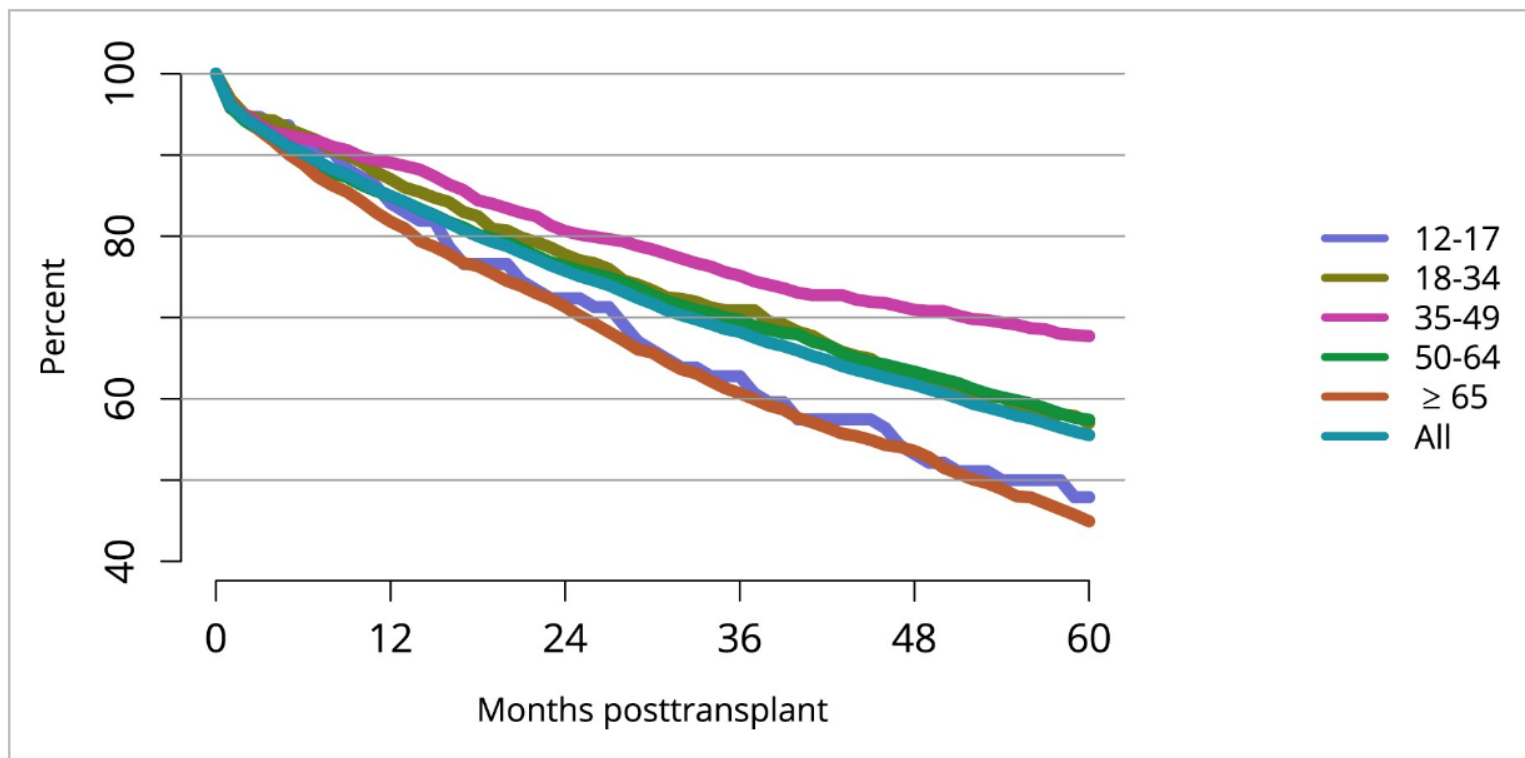


- Types of lung transplant
- **Lobe**
- A lobe transplant is a surgery in which part of a living or deceased donor's lung is removed and used to replace the recipient's diseased lung. In living donation, this procedure requires the donation of lobes from two different people, replacing a lung on each side of the recipient. Donors who have been properly screened should be able to maintain a normal quality of life despite the reduction in lung volume. In deceased lobar transplantation, one donor can provide both lobes.
- **Single-lung**
- Many patients can be helped by the transplantation of a single healthy lung. The donated lung typically comes from a donor who has been pronounced [brain-dead](#).
- **Double-lung**
- Certain patients may require both lungs to be replaced. This is especially the case for people with [cystic fibrosis](#), due to the bacterial colonization commonly found within such patients' lungs; if only one lung were transplanted, bacteria in the native lung could potentially infect the newly transplanted organ.
- **Heart–lung**

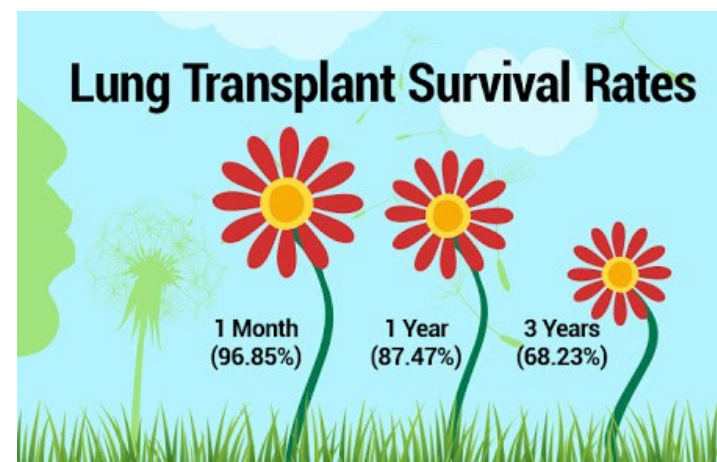




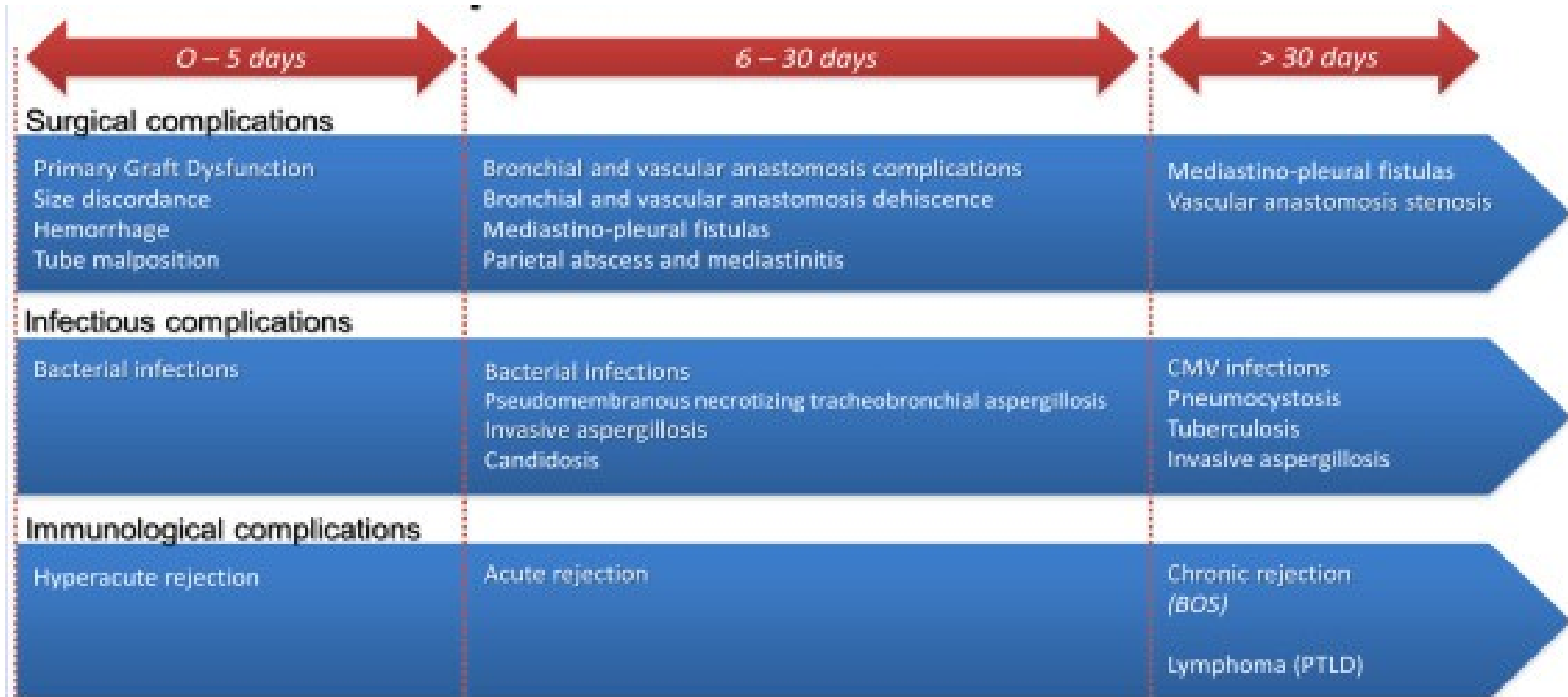




**Patient survival among lung transplant recipients aged 12 years or older, 2009-2011, by age.** Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.



## • Complications



- **Liver Transplantation**

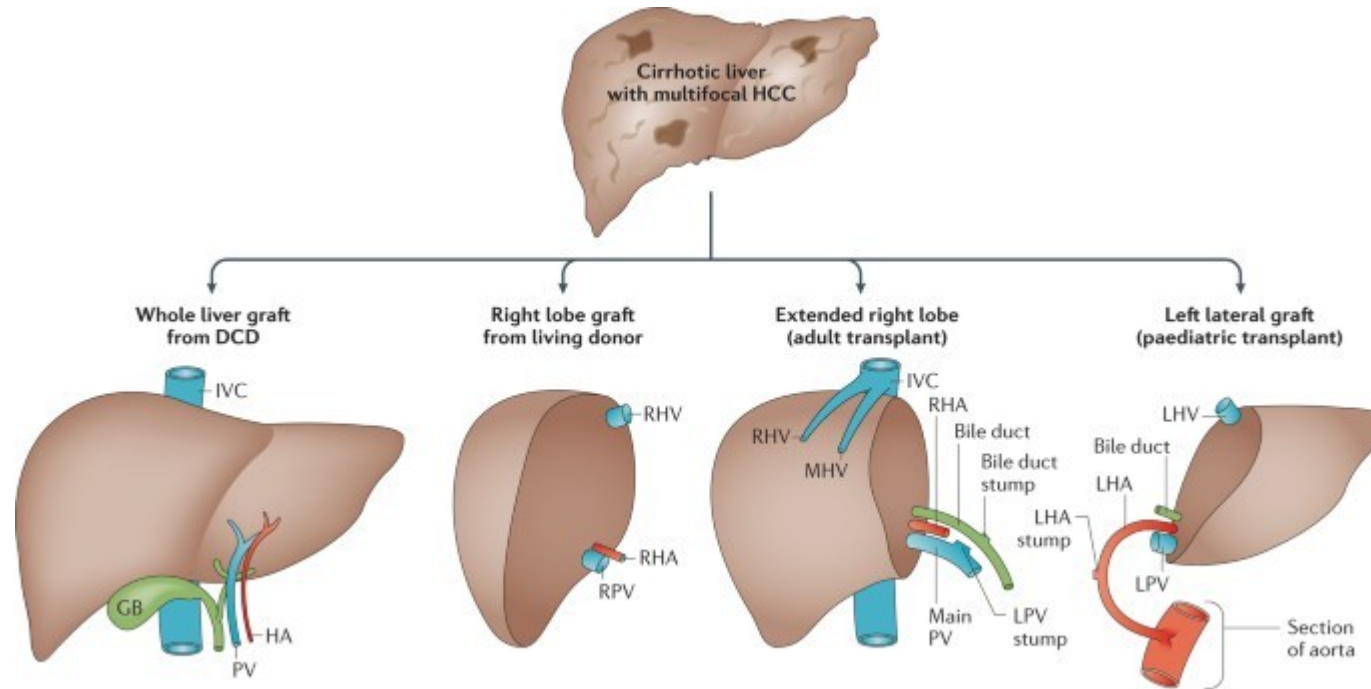
- Liver transplantation or hepatic transplantation is the replacement of a diseased liver with the healthy liver from another person (allograft).
- Liver transplantation is a treatment option for end-stage liver disease and acute liver failure, although availability of donor organs is a major limitation.
- The most common technique is orthotopic transplantation, in which the native liver is removed and replaced by the donor organ in the same anatomic position as the original liver.
- The surgical procedure is complex, requiring careful harvest of the donor organ and meticulous implantation into the recipient. Liver transplantation is highly regulated, and only performed at designated transplant medical centers by highly trained transplant physicians and supporting medical team.

- **Indications**

- Liver transplant is a treatment option for people with liver failure whose condition can't be controlled with other treatments and for some people with liver cancer.
- It is more often used to treat chronic liver failure. Chronic liver failure occurs slowly over months and years.
- Chronic liver failure may be caused by a variety of conditions. The most common cause of chronic liver failure is scarring of the liver (cirrhosis). Cirrhosis is the most frequently reason for a liver transplant.
- **Major causes of cirrhosis leading to liver failure and liver transplant include:**
  - Hepatitis B and C.
  - Alcoholic liver disease, which causes damage to the liver due to excessive alcohol consumption.
  - Nonalcoholic fatty liver disease, a condition in which fat builds up in the liver, causing inflammation or liver cell damage.
  - Genetic diseases affecting the liver, including hemochromatosis, which causes excessive iron buildup in the liver, and Wilson's disease, which causes excessive copper buildup in the liver.
  - Diseases that affect the bile ducts (the tubes that carry bile away from the liver), such as primary biliary cirrhosis, primary sclerosing cholangitis and biliary atresia. Biliary atresia is the most common reason for liver transplant among children.

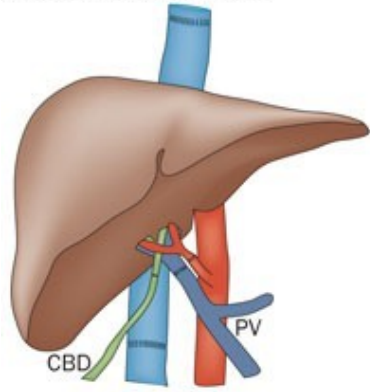
## • **Contraindications**

- someone with advanced liver cancer, with known/likely spread beyond the liver
- active alcohol/substance abuse
- severe heart/lung disease
- existing high cholesterol levels in the patient
- dyslipidemia

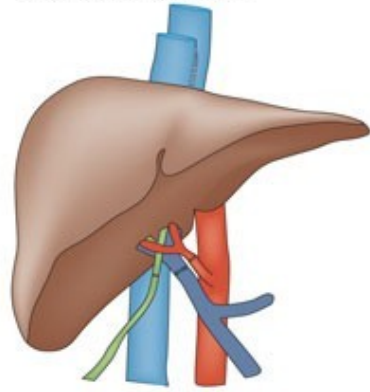




**a Conventional technique**

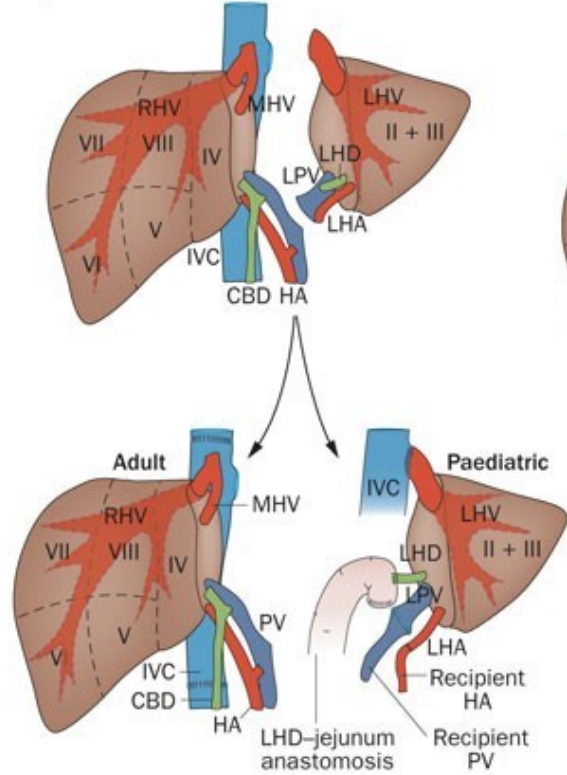


**b Piggyback technique**

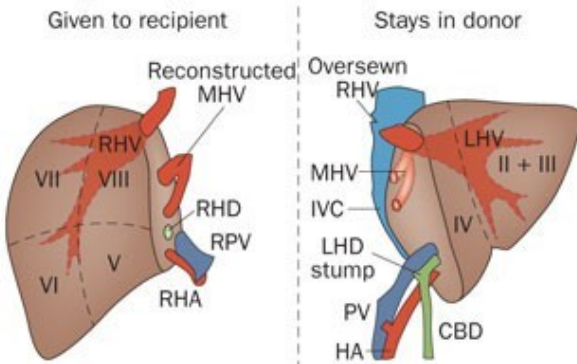


- IVC inferior vena cava
- HA hepatic artery
- PV portal vein
- CBD common bile duct
- LHA left hepatic artery
- LPV left portal vein
- LHD left hepatic duct
- LHV left hepatic vein
- RHA right hepatic artery
- RPV right portal vein
- RHD right hepatic duct
- RHV right hepatic vein
- MHV middle hepatic vein

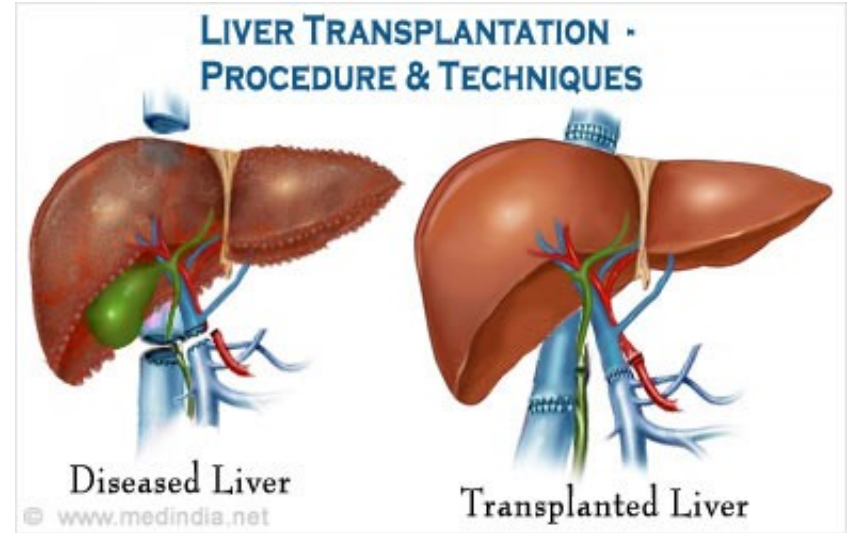
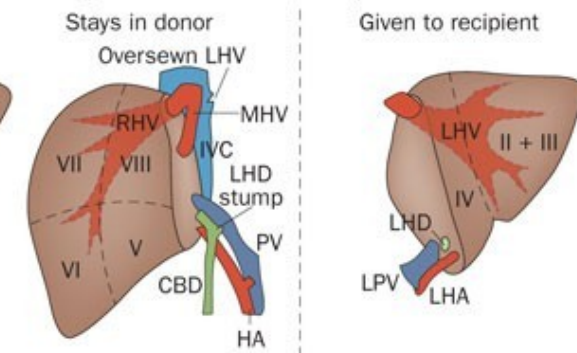
**c Split liver**



**d Living donor right lobe liver transplantation**



**e Living donor left lobe liver transplantation**





- RISKS/COMPLICATIONS

- **Graft rejection**

- After a liver transplantation, immune-mediated rejection (also known as rejection) of the allograft may happen at any time. Rejection may present with lab findings: elevated AST, ALT, GGT; abnormal liver function values such as prothrombin time, ammonia level, bilirubin level, albumin concentration; and abnormal blood glucose. Physical findings may include encephalopathy, jaundice, bruising and bleeding tendency. Other nonspecific presentation may include malaise, anorexia, muscle ache, low fever, slight increase in white blood count and graft-site tenderness.

- **Biliary complications**

- Biliary complications include biliary stenosis, biliary leak, and ischemic cholangiopathy. The risk of ischemic cholangiopathy increases with longer durations of cold ischemia time, which is the time that the organ does not receive blood flow (after death/removal until graft placement).[2]

- **Vascular complications**

- Vascular complications include thrombosis, stenosis, pseudoaneurysm, and rupture of the hepatic artery.[1] Venous complications occur less often compared with arterial complications, and include thrombosis or stenosis of the portal vein, hepatic vein, or vena cava.

# Thanks for your attentation

