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ARTIFICIAL KIDNEY

Course Code: XECO2

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ARTIFICIAL KIDNEY

Indication

Principle of Haemodialysis,

Membrane, Dialysate,

Types of filter and membranes,

Different types of hemodialyzers,

Monitoring Systems,

Wearable Artificial Kidney,

Implanting Type.

ARTIFICIAL KIDNEY

The term "artificial kidney" typically refers to a **medical device or treatment** that is designed to perform the functions of a healthy human kidney

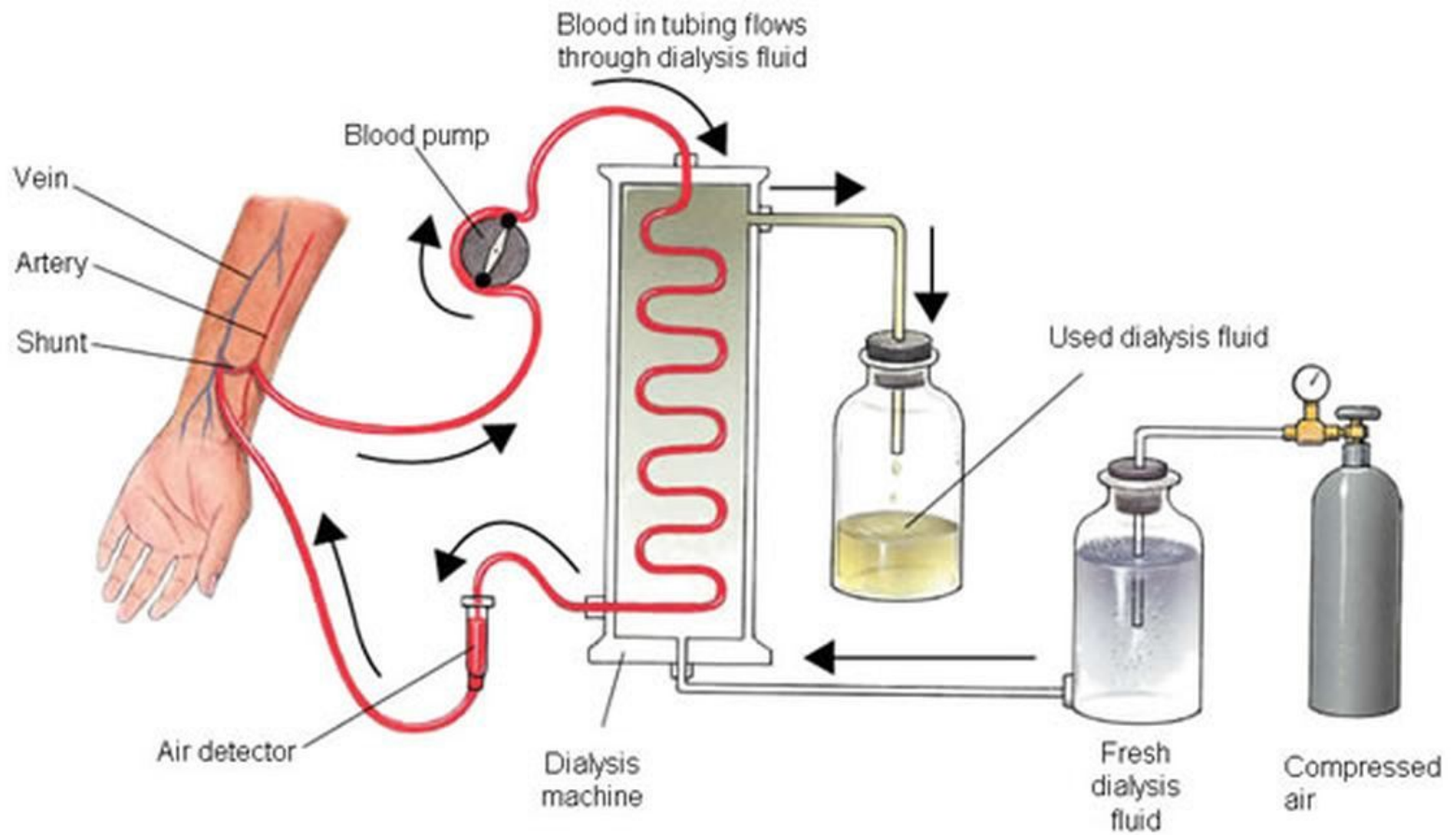
Kidneys role

- Filtering waste products
- Filtering Excess fluids from the blood
- Regulating electrolyte levels
- Maintaining overall fluid balance in the body

Primary Approaches to Creating Artificial Kidneys

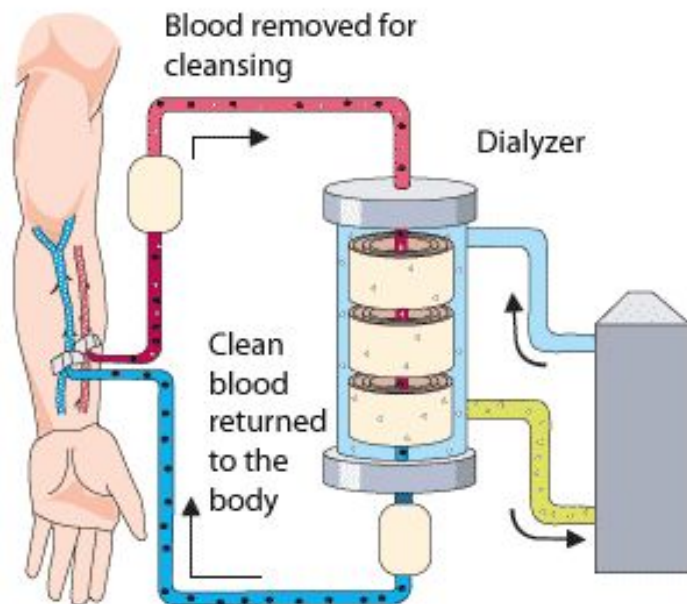
Hemodialysis

Peritoneal Dialysis



Hemodialysis

Blood is removed from the patient's body, passed through a special filter (dialyzer) that performs the filtration and then returned to the patient's body.



PMIST,ECE



Processes Hemodialysis

Diffusion:

Substances like urea, creatinine and electrolytes that are present in higher concentrations in the blood diffuse across the semipermeable membrane into the dialysate, which has lower concentrations of these substances

Ultrafiltration:

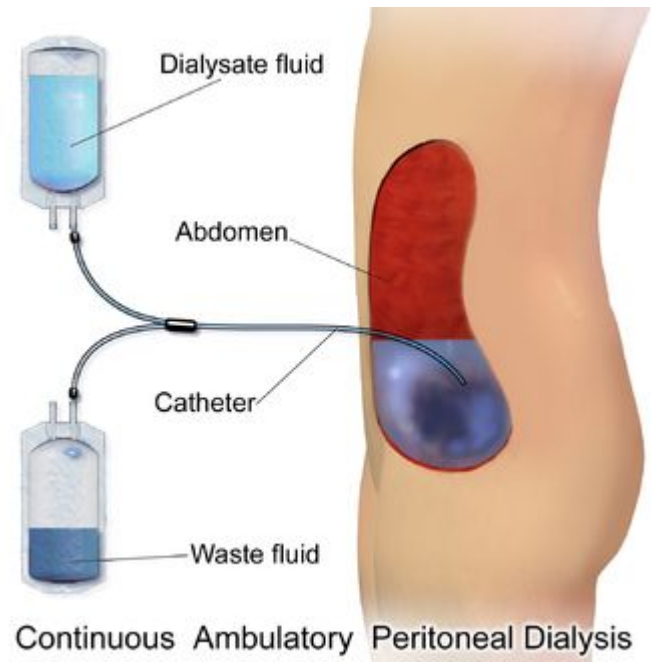
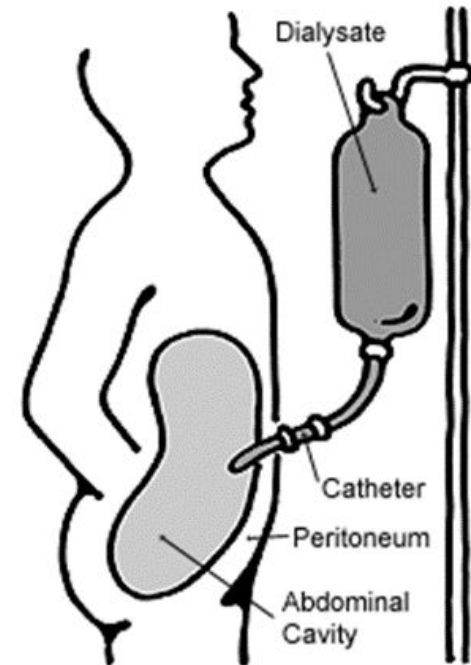
Excess fluids in the blood are removed through a process called ultrafiltration

Electrolyte Balance:

The composition of the dialysate ensures that electrolyte levels in the blood are properly maintained

Peritoneal Dialysis

- The body's own peritoneal membrane (lining of the abdominal cavity) to filter waste products and excess fluids
- A special dialysis - abdominal cavity through a catheter and the peritoneal membrane acts as a filter, allowing waste and excess fluid to move from the blood into the solution.



Indication of Hemodialysis in Artificial Kidney

End-Stage Renal Disease (ESRD) - kidney failure

The kidneys are no longer able to adequately filter waste products and excess fluids from the blood

Hemodialysis using an artificial kidney is a treatment option for these individuals to replace the lost kidney function

Principle of Hemodialysis in Artificial Kidney

The principle of hemodialysis in an artificial kidney is similar to traditional hemodialysis but with the added technology and engineering of the artificial kidney device

Blood Access

Blood Filtration

Dialysate

Diffusion and Ultrafiltration

Return of Purified Blood

Treatment Session

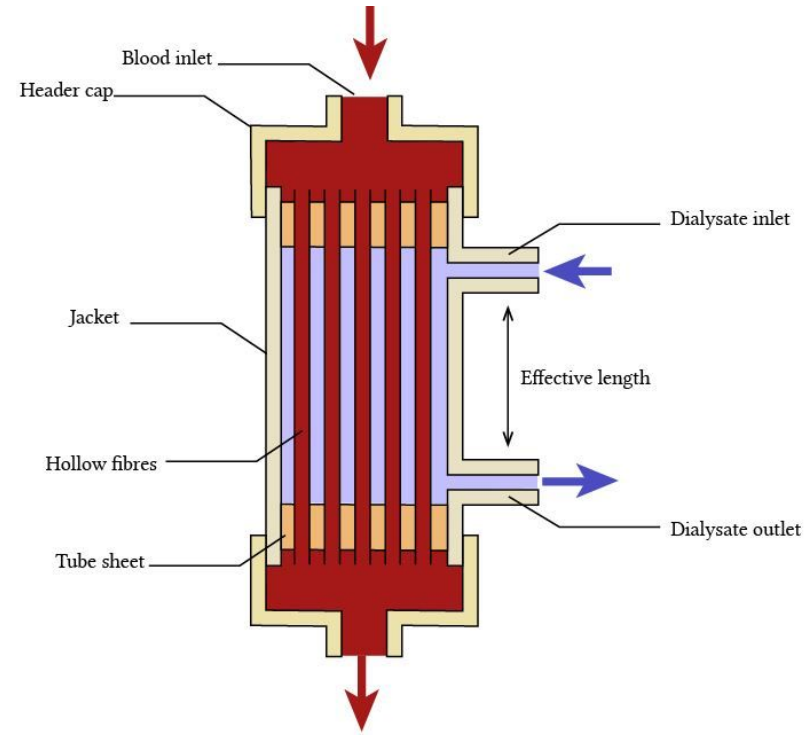
MEMBRANE

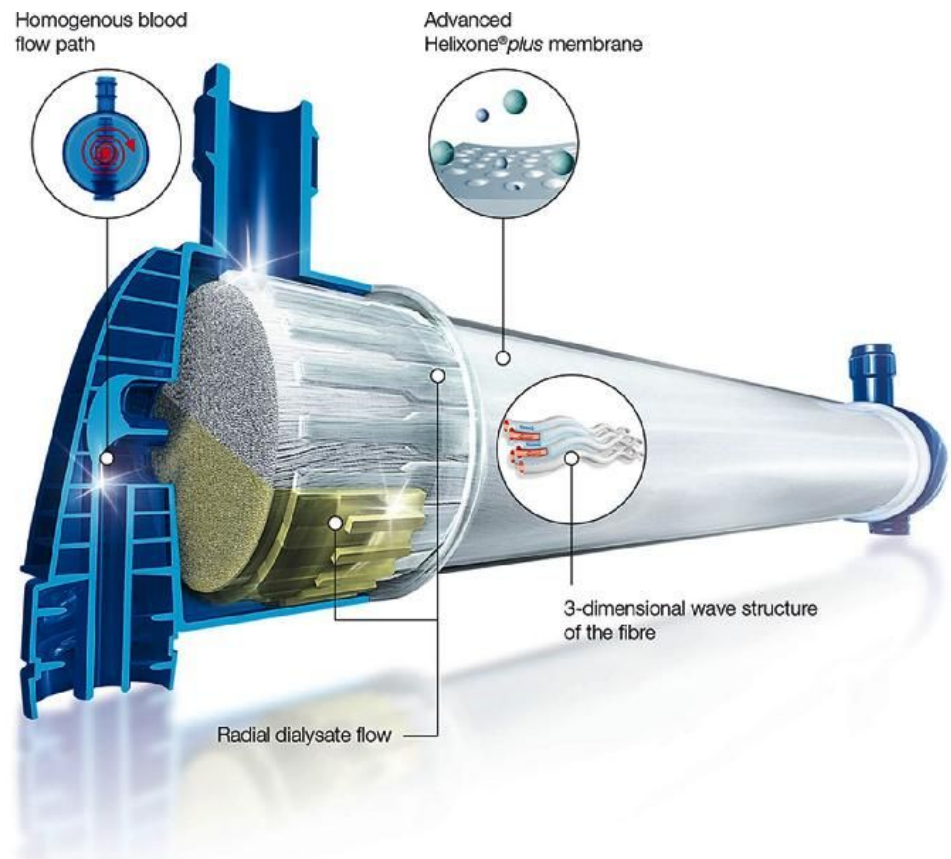
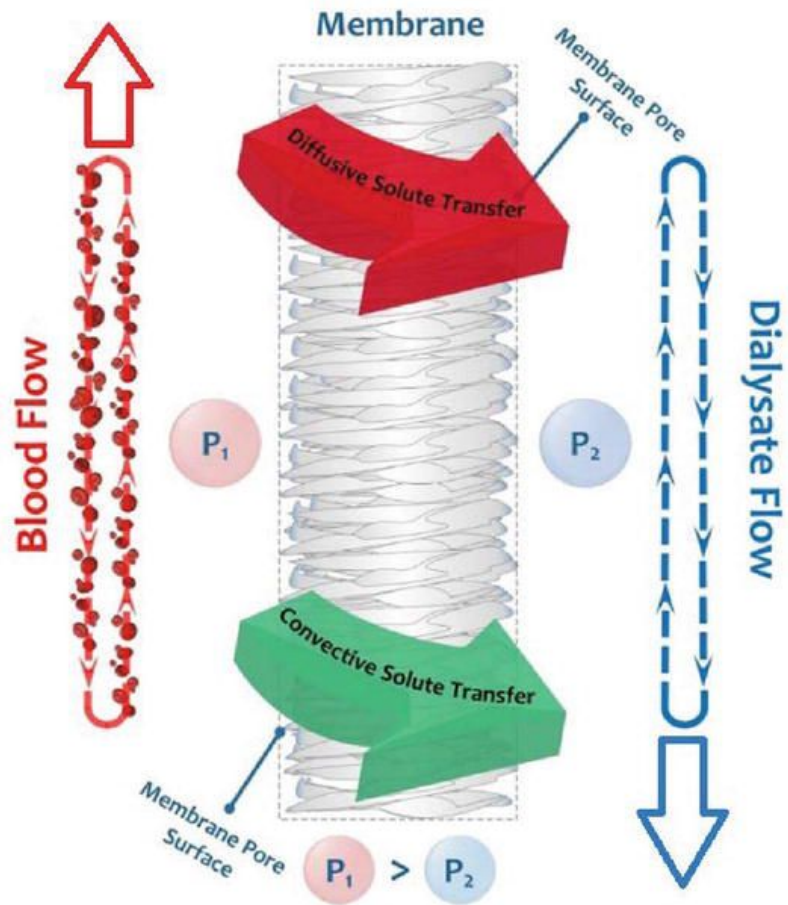
The dialysis membrane is a main component of the hemodialysis process

It is a semipermeable material that allows certain substances to pass through while blocking others.

Small waste molecules (like urea and creatinine) and excess fluids diffuse across the membrane

Larger molecules are retained.
(like proteins and blood cells)





Functions and characteristics of the membrane in an Artificial kidney

Selective Permeability: it allows certain molecules to pass through while blocking others - Small waste molecules

Molecular Weight Cut-off: determines the size of molecules that can pass through - retaining larger components

High Surface Area: To enhance the efficiency of filtration and exchange

Biocompatibility: The membrane material must be biocompatible - it should not cause adverse reactions to the patient's blood

Removal of Endotoxins: contribute to inflammation in patients with kidney failure

Flux Characteristics: to allow molecules to pass through

Dialysis Efficiency: the overall efficiency of the dialysis process

DIALYSATE

Dialysate is the special solution used in hemodialysis to create a concentration gradient that drives the removal of waste and excess substances from the blood

An artificial kidney or hemodialysis, the dialysate is a specialized solution that is used to facilitate the exchange of substances between the patient's blood and the dialysis machine.

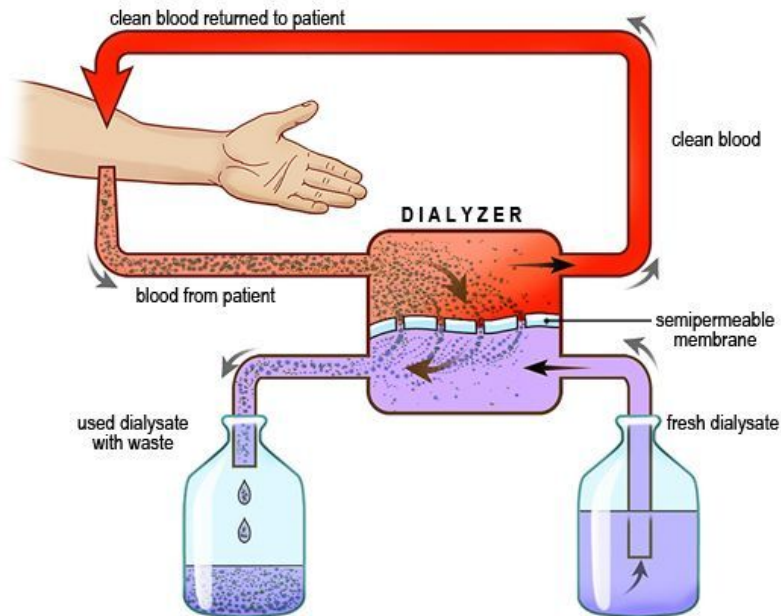
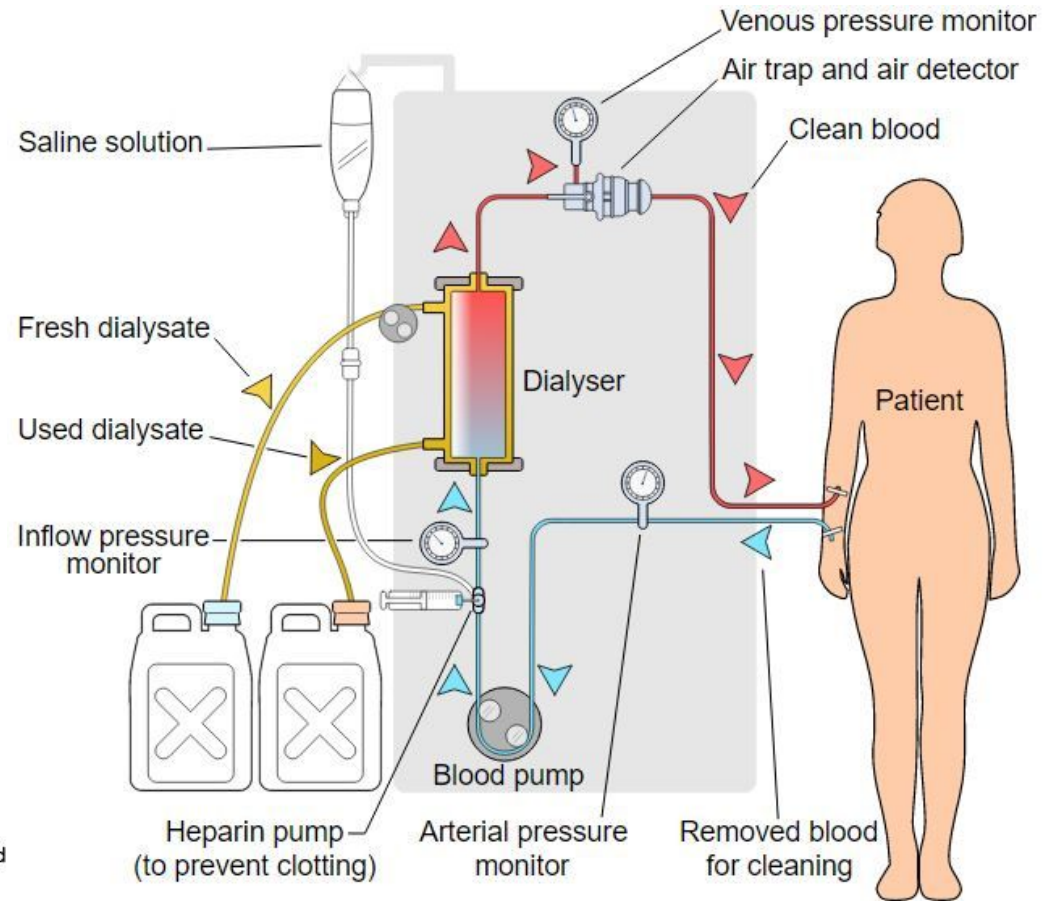
The dialysate plays a crucial role in removing waste products, excess fluids, and electrolytes from the patient's blood

DIALYSATE

Types

Acetate Dialysate

Bicarbonate Dialysate



Composition of Dialysate

It is formulated to mimic the electrolyte and chemical balance of a healthy individual's blood.

Principle of Dialysis

Creating a concentration gradient between the patient's blood and the dialysate

The movement of substances across the semipermeable membrane of the artificial kidney

MONITORING SYSTEMS

Hemodialysis treatment requires careful monitoring to ensure patient safety and treatment efficacy.

Monitoring systems track parameters:

- Blood Pressure
- Heart Rate
- Oxygen Saturation
- Temperature Monitoring
- Temperature Monitoring
- Dialysate Composition Monitoring
- Urea and Creatinine Monitoring
- Ultrafiltration Monitoring
- Alarms and Alerts
- Connectivity and Data Recording

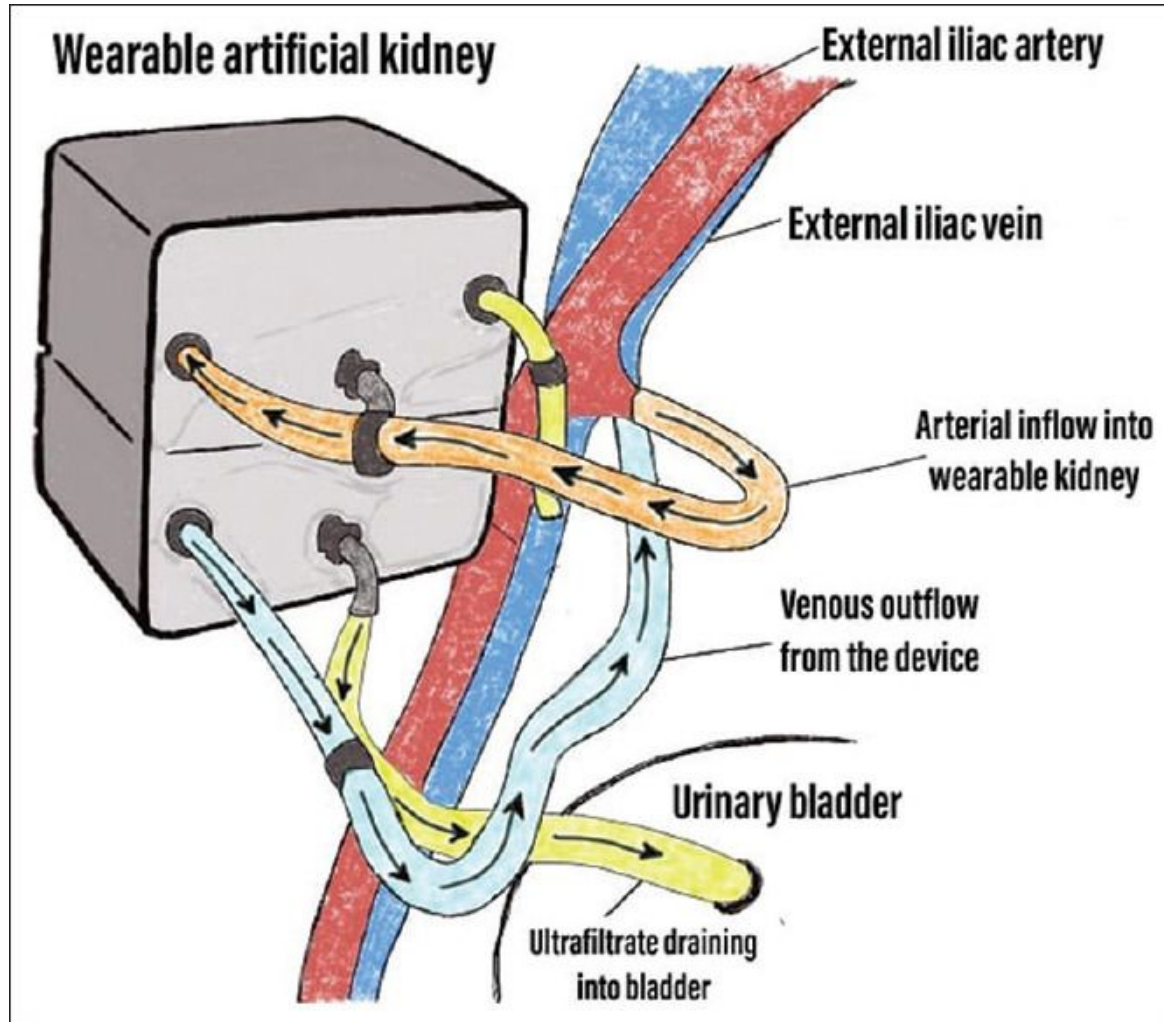
WEARABLE ARTIFICIAL KIDNEY



- A patient can wear throughout the day, allowing for continuous or frequent dialysis.
- This approach aims to provide more natural and efficient removal of waste products and fluids compared to traditional intermittent hemodialysis sessions.

<https://pharmacy.ucsf.edu/news/2021/09/kidney-project-successfully-tests-prototype-bioartificial-kidney>

WEARABLE ARTIFICIAL KIDNEY



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9872927/>

Components- WEARABLE ARTIFICIAL KIDNEY

- **Blood Access**
- **Miniaturized Dialysis System**
- **Fluid Management**
- **Power Source**

Advantages of wearable artificial kidney:

- **Continuous or Frequent Therapy**
- **Improved Quality of Life**
- **Reduced Treatment Burden**
- **Steady Clearance of Toxins**

Challenges in wearable artificial kidney:

- **Miniaturization**
- **Blood Compatibility**
- **Safety and Reliability**
- **Regulatory Approval**

Kidney function

- <https://www.youtube.com/watch?v=fJsE5r7xetc>
- <https://www.youtube.com/watch?v=vTIUtIQKlco>

Dialysis

- <https://www.youtube.com/watch?v=kw9VbU-PVK4>
- <https://www.youtube.com/watch?v=lgwZTIOAu30>
- Artificial kidney
- <https://www.youtube.com/watch?v=vUQZLgkw2yM>
- <https://www.youtube.com/watch?v=aLVUD3hP0PA>
- <https://www.youtube.com/watch?v=Oe4pk9PkURE>
- <https://www.youtube.com/watch?v=lyjhlGFWSh0>