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HEART LUNG MACHINE AND ARTIFICIAL HEART

Course Code: XECO2

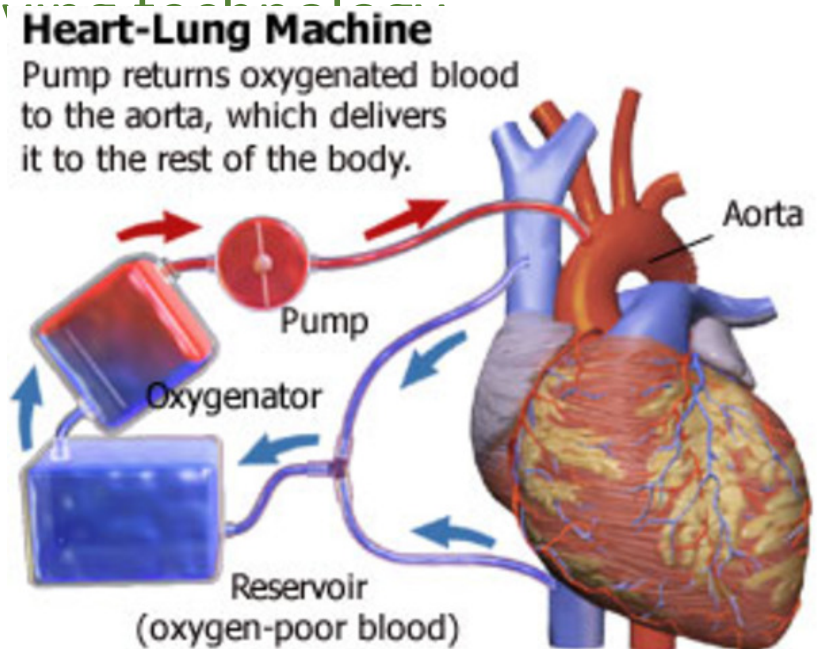
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HEART LUNG MACHINE

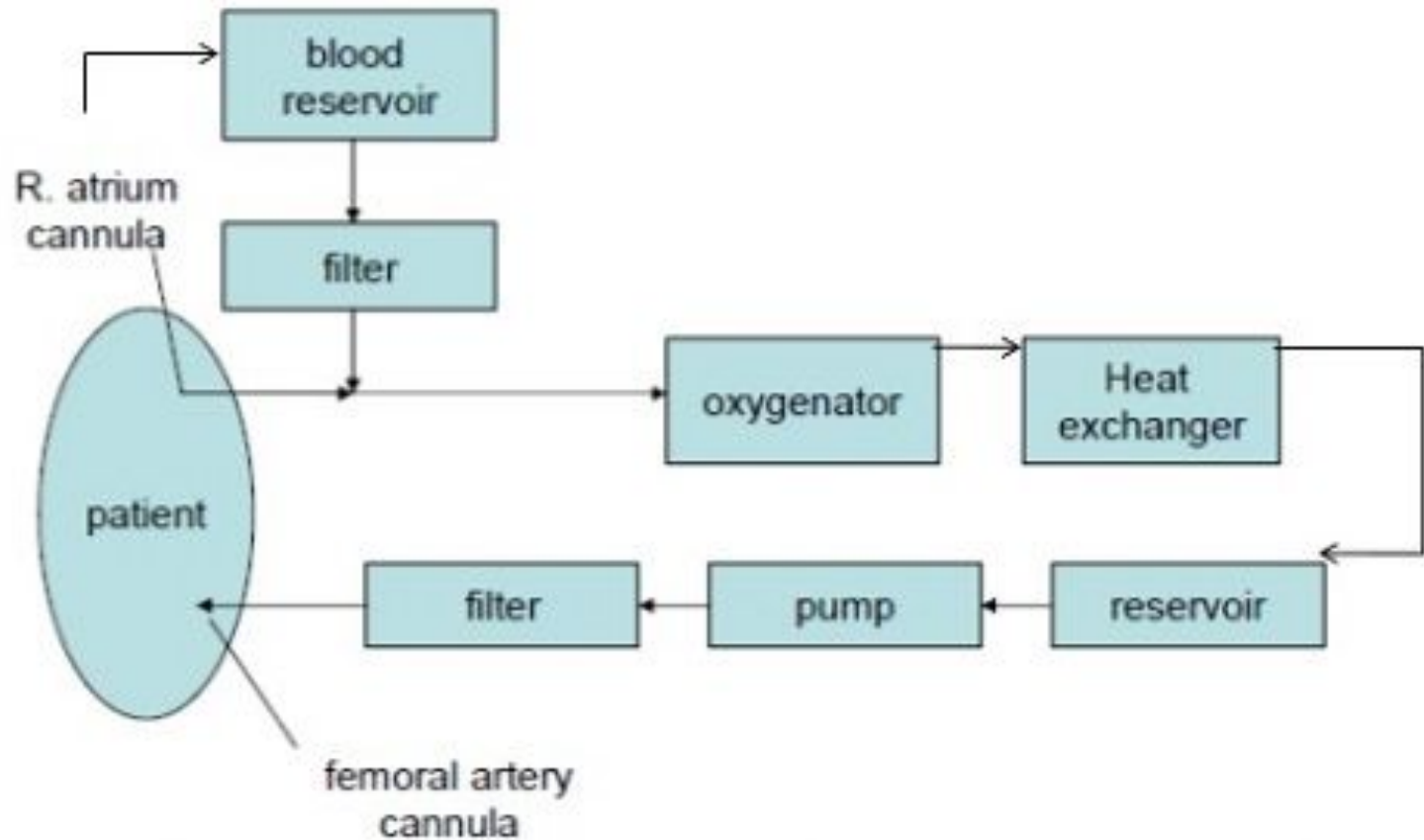
- A heart-lung machine, also known as a **cardiopulmonary bypass (CPB) machine**.
- In the medical device used for open-heart surgery to temporarily take over the functions of the heart and lungs.
- To maintaining **circulation and oxygenation of the blood**
- Heart lung machine is a life saving technology



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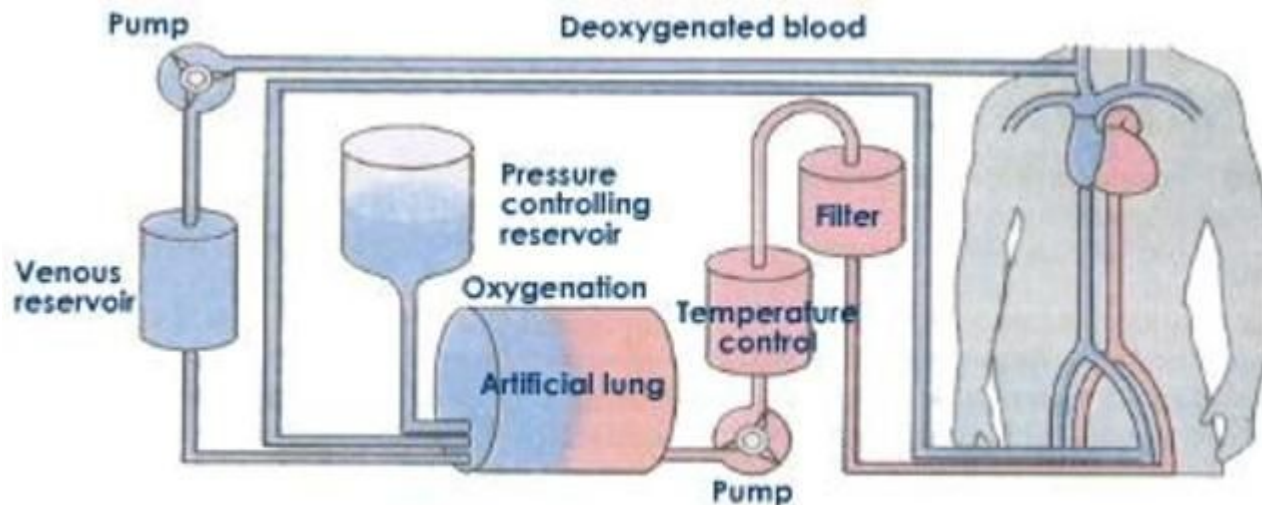
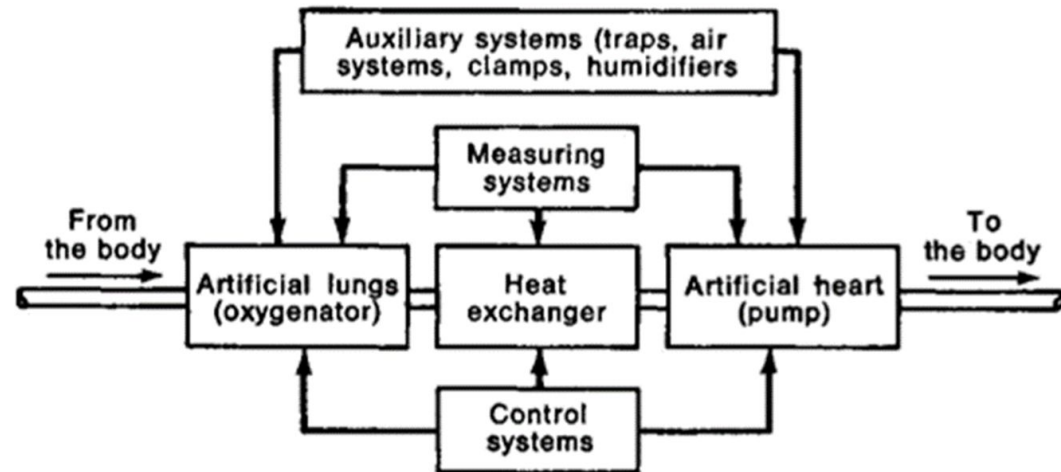


Heart Lung Machine Block Diagram



A heart-lung machine works and its components:

- Blood Circulation
- Oxygenation
- Temperature Control
- Monitoring System

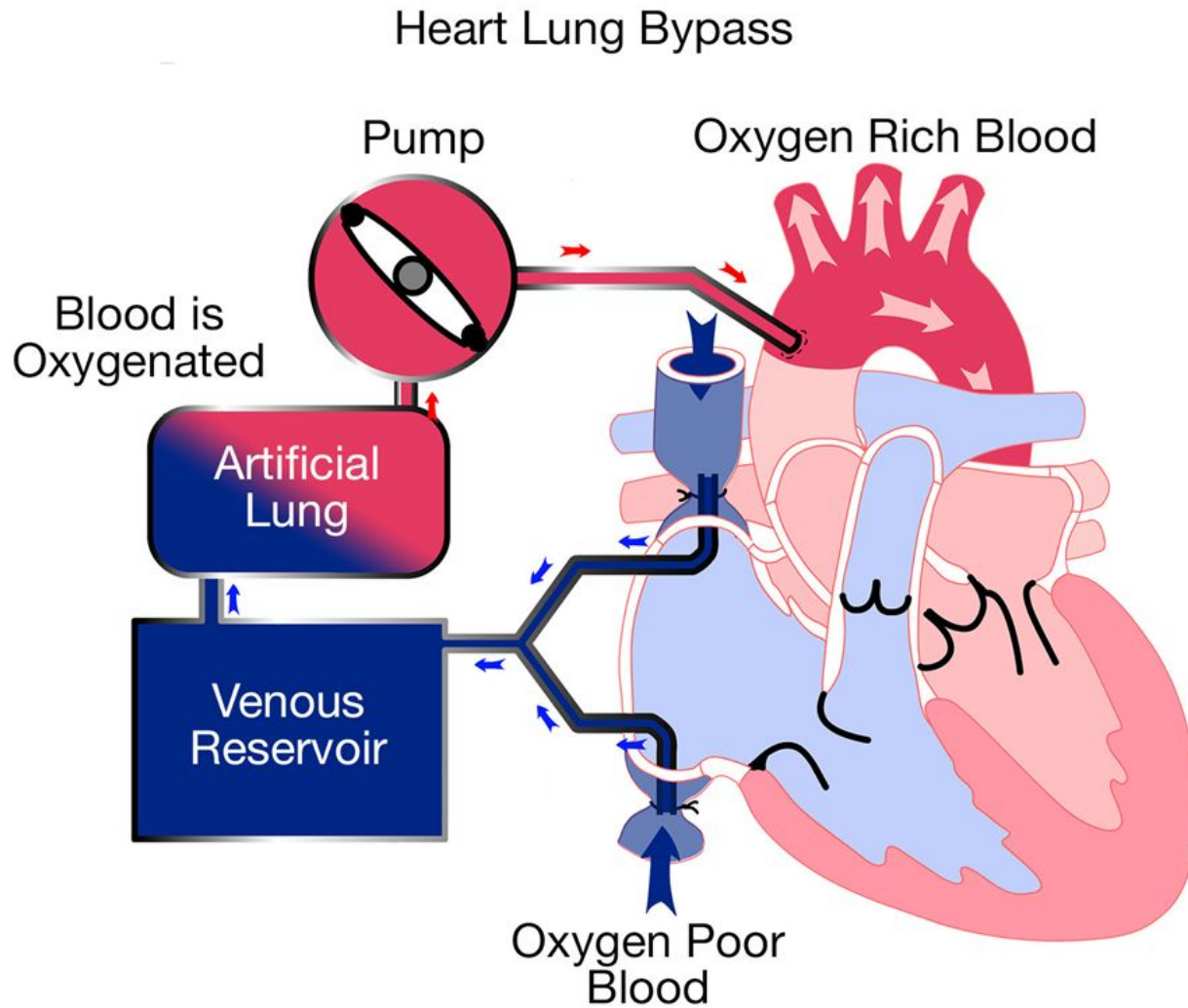


Heart-lung machine PMIST,ECE

Condition to be satisfied by the H/L System:

- **Efficient Gas Exchange** (carbon dioxide, a waste product of metabolism)
- **Adequate Blood Circulation** (to supply nutrients, hormones, and oxygen to cells)
- **Heart Contraction and Relaxation**
- **Regulation of Blood Pressure**
- **Maintenance of pH and Electrolyte Balance** (acid-base balance and electrolyte levels)
- **Transport of Nutrients and Waste Products**
- **Temperature Regulation**
- **Oxygen Transport Capacity**
- **Adaptation to Physiological Stress**
- **Coordination with Other Systems**

Components of a heart-lung machine:



Components of a heart-lung machine:

Oxygenator: Oxygenates the blood by removing carbon dioxide and adding oxygen.

Pump: The pump is responsible for circulating blood throughout the body

Heat Exchanger: To regulate the patient's body temperature.

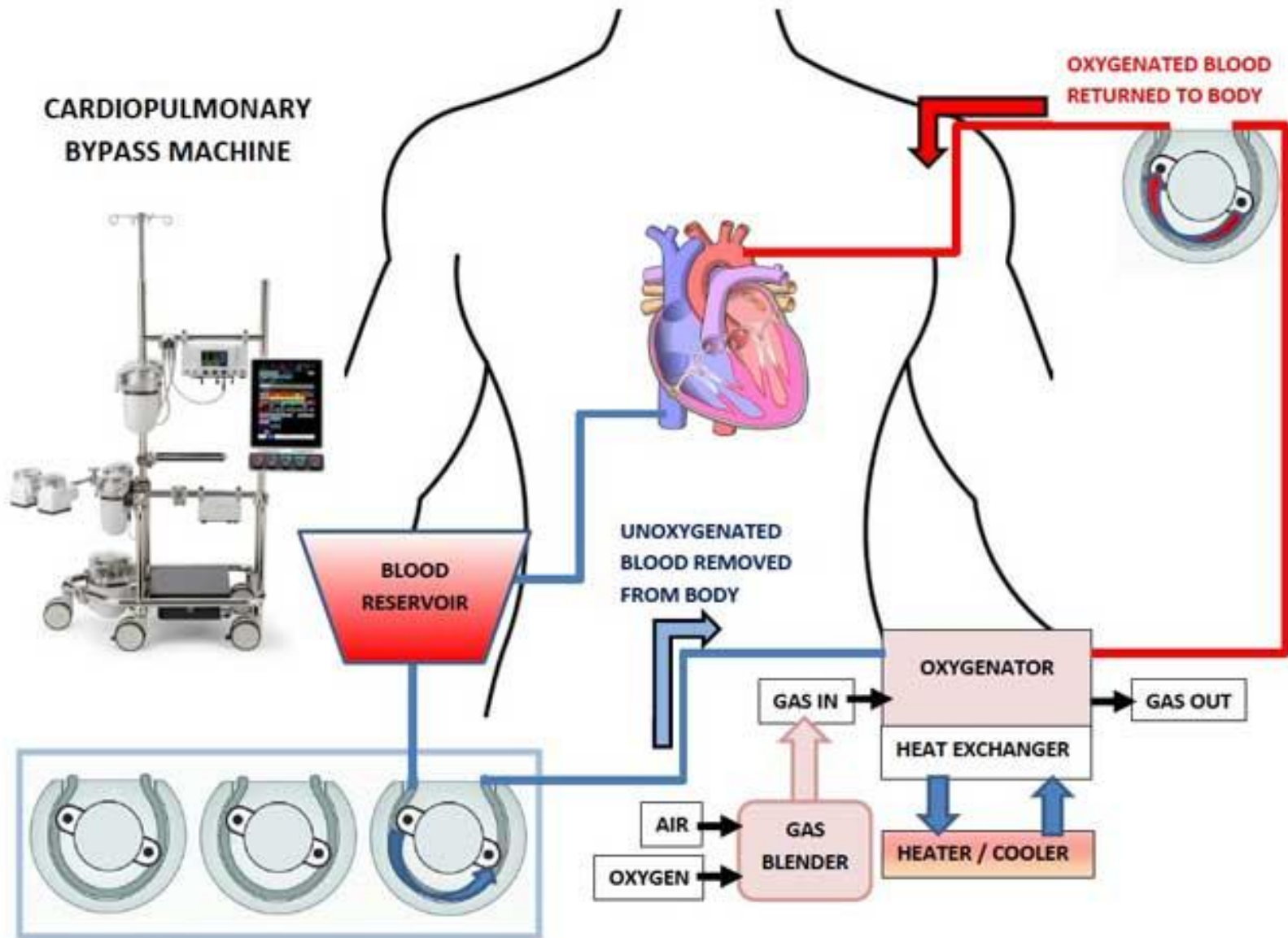
Filters: Filters to remove air bubbles and debris from the blood.

Tubing and Cannulas: The machine pumps blood out of the body, oxygenates it, and then returns it to the body through these tubes.

Monitoring and Control System

Anticoagulation System: To prevent blood clotting during circulation through the machine

Shunting: Redirection or diversion of blood flow from one area of the circulatory system to another.



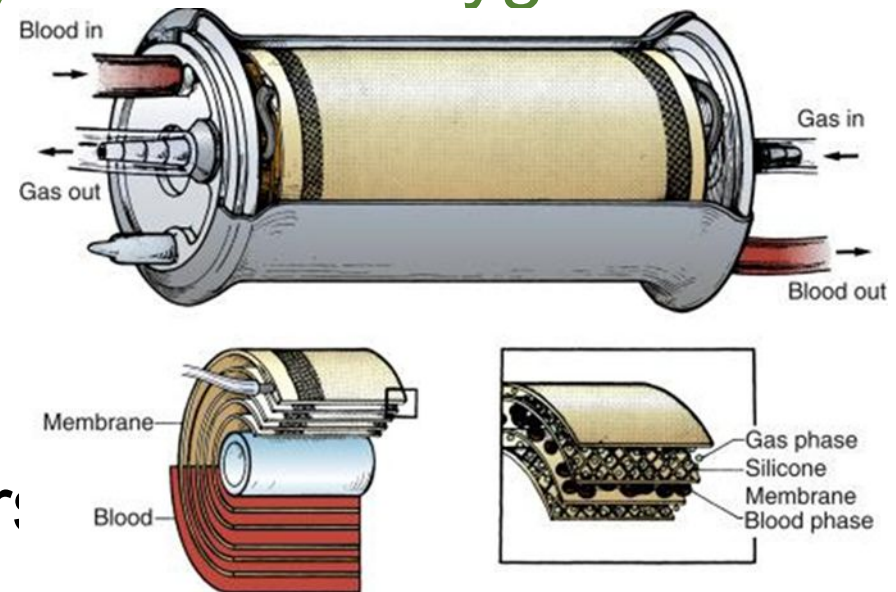
Oxygenator

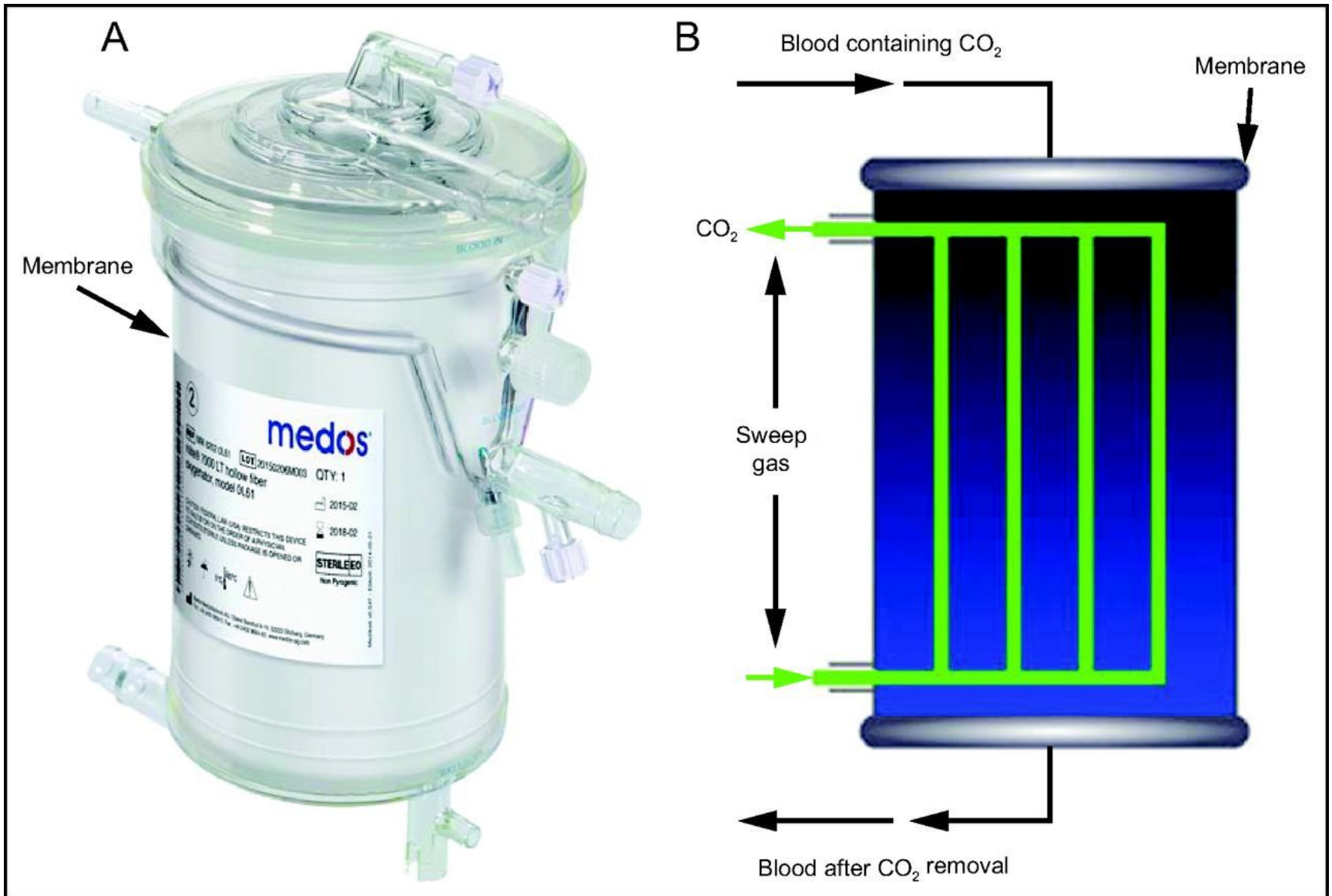
The oxygenator is planned to move oxygen to the infused blood and take away carbon dioxide from venous blood.

The oxygenator assembly allows to oxygenate the blood.

Types:

1. Bubble Oxygenators
2. Membrane Oxygenators
3. Hollow Fiber Oxygenators





Bubble Oxygenators

- These are the simplest and oldest type of oxygenators.
- They consist of a gas-permeable membrane through which oxygen is bubbled into the blood.
- As blood flows over the membrane, oxygen diffuses into the blood, and carbon dioxide diffuses out.
- The bubbles created by the oxygen flow help in gas exchange.
- Bubble oxygenators are simple but less efficient compared to other types.

Membrane Oxygenators

- Also known as film or flat-sheet oxygenators, these use a thin, porous membrane to separate the blood and the oxygenating gas.
- Oxygen and carbon dioxide diffuse across the membrane due to concentration gradients.
- Membrane oxygenators are more efficient and cause less damage to blood components compared to bubble oxygenators.

Hollow Fiber Oxygenators

- These oxygenators use a bundle of hollow fibers made of a gas-permeable material.
- Blood flows through the fibers, while oxygenating gas flows around them.
- Oxygen and carbon dioxide exchange occurs through the walls of the fibers.
- Hollow fiber oxygenators are efficient and offer a large surface area for gas exchange.

Pumps in Heart-Lung Machines

The pump generates the necessary blood flow to maintain circulation.

Roller pump

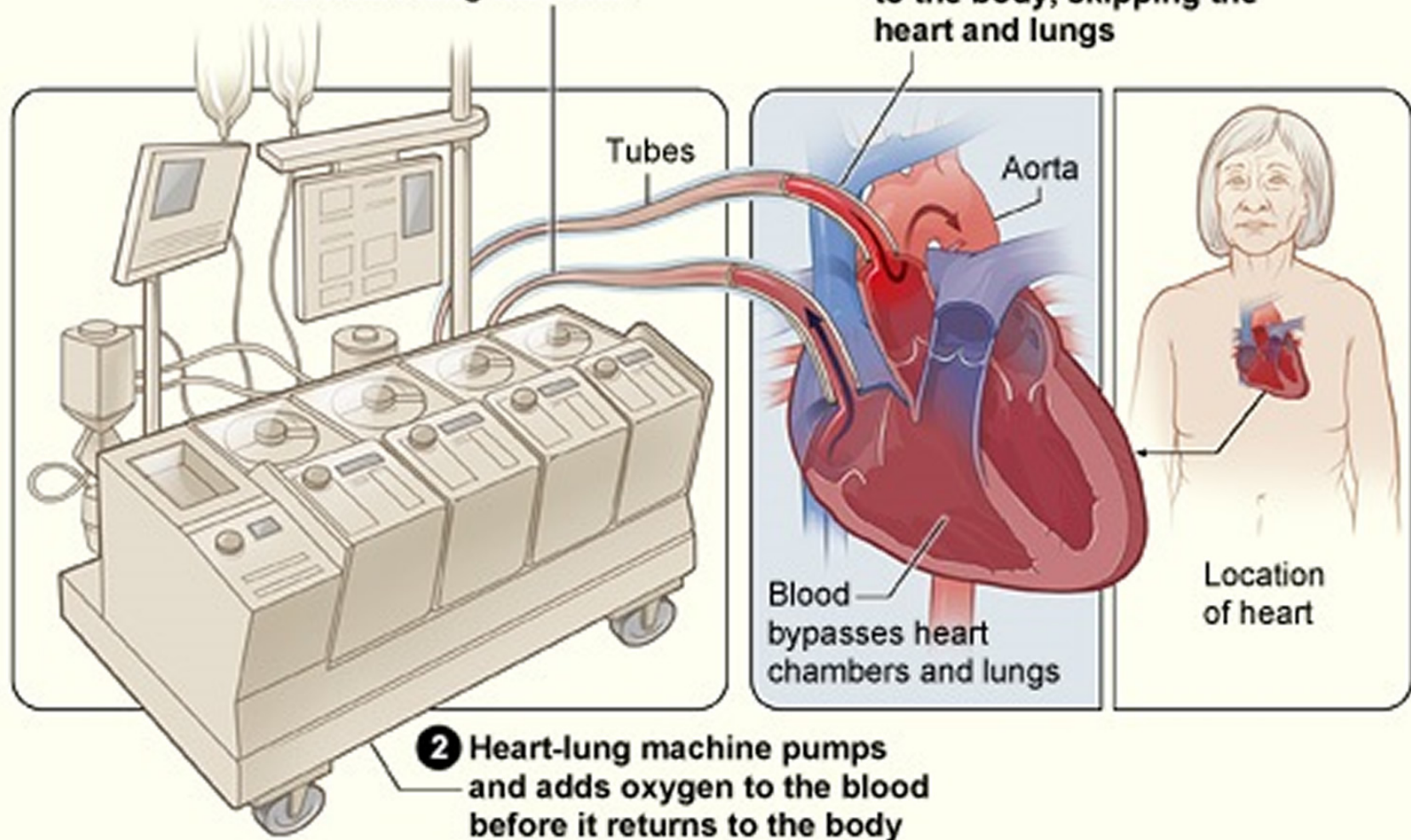
- Roller pumps are commonly used in heart-lung machines.
- They work by compressing flexible tubing with rotating rollers, creating a pulsatile flow of blood (Periodic variations).
- Roller pumps can generate high pressures and are capable of providing both pulsatile and continuous flow, depending on the setup.

Centrifugal pump

- A rotating impeller to generate a continuous flow of blood.
- They are often preferred for their ability to provide a consistent and gentle blood flow.

- 1** Oxygen-poor blood leaves the heart to enter the heart-lung machine

- 3** Oxygen-rich blood returns to the body, skipping the heart and lungs



Monitoring Process:

During cardiac surgery with a heart-lung machine, **various parameters are monitored closely** to ensure the patient's safety and well-being.



Types of Monitoring Process:

Blood Pressure

Monitoring blood pressure helps assess the **adequacy of perfusion to organs and tissues**.

Oxygenation and Gas Exchange

Monitoring oxygen saturation and the levels of gases such as oxygen and carbon dioxide in the blood ensures **proper oxygenation and ventilation**.

Temperature

Maintaining a stable body temperature is crucial for preventing complications during surgery.

Electrocardiogram (ECG)

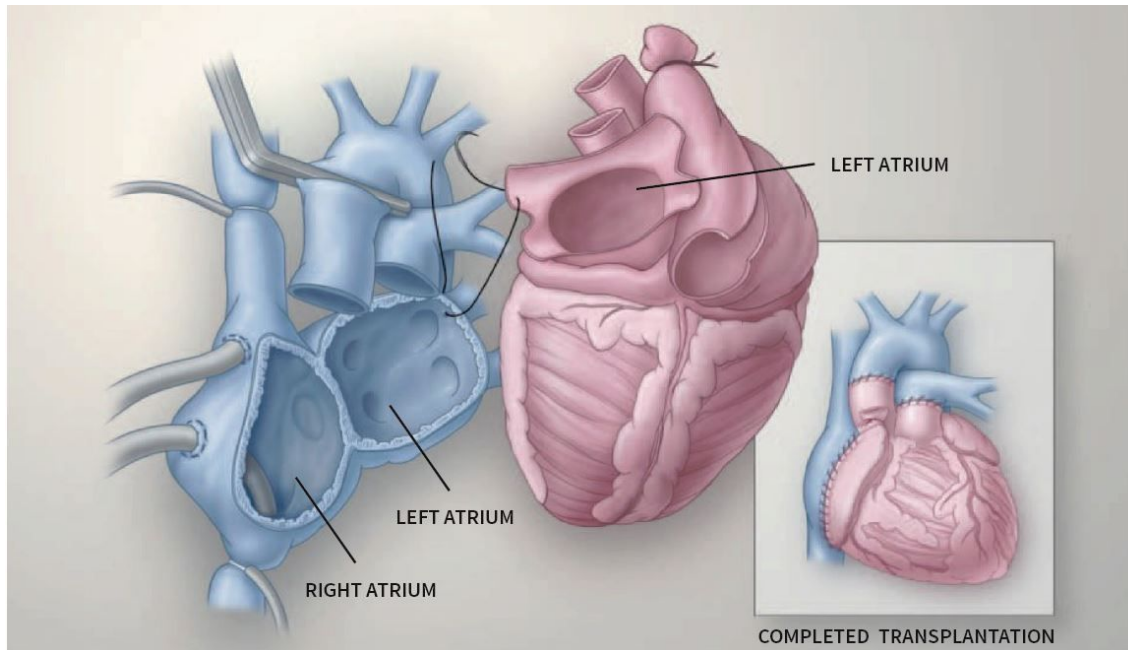
Monitoring the patient's heart rhythm helps detect any irregularities or changes during the procedure.

Blood Flow and Pump Performance

Monitoring the flow rate of the heart-lung machine's pump helps ensure that the desired blood flow is being maintained.

Indications for Cardiac Transplant

- A cardiac transplant, also known as a heart transplant.
- Patient's heart is severely damaged/diseased and is no longer able to pump blood effectively.



Indications for cardiac transplant

End-Stage Heart Failure: When other treatments, such as medication, surgery or medical devices have failed to adequately manage advanced heart failure.

Cardiomyopathy: Severe cardiomyopathies, such as dilated cardiomyopathy or restrictive cardiomyopathy, where the heart muscle becomes weakened and cannot contract effectively.

Coronary Artery Disease: Advanced coronary artery disease with significant damage to the heart muscle and inadequate blood supply.

Congenital Heart Defects: Complex congenital heart defects that cannot be effectively repaired through surgery or other interventions.

Valvular Heart Disease: Severe valvular diseases, such as end-stage valvular stenosis or regurgitation, that cannot be successfully treated with valve replacement or repair.

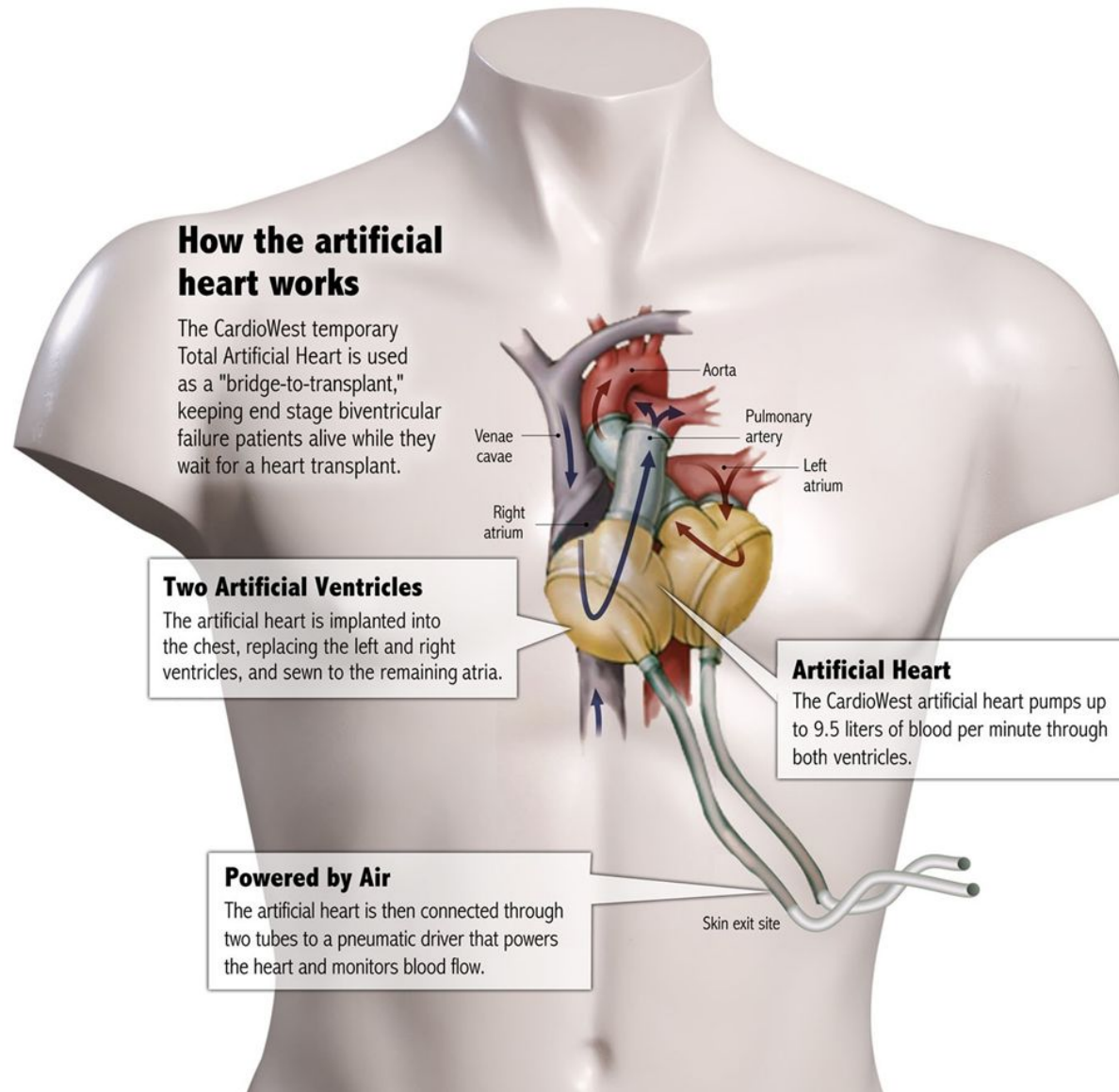
Refractory Arrhythmias: When life-threatening arrhythmias cannot be controlled with medication or other treatments.

Certain Inherited Heart Diseases: Inherited conditions, such as familial cardiomyopathies, where heart function deteriorates significantly.

Artificial Heart

- An Artificial Heart is a **mechanical device**
- To **replace or assist the natural pumping** action of a failing human heart.
- It is used for **patients with end-stage heart failure**
- Donor organ.

Artificial Heart



Types of Artificial Hearts

Total Artificial Heart (TAH):

A TAH is a device that completely replaces both the **left and right ventricles** of the heart.

The TAH typically consists of two artificial ventricles and is **connected to an external power source**.

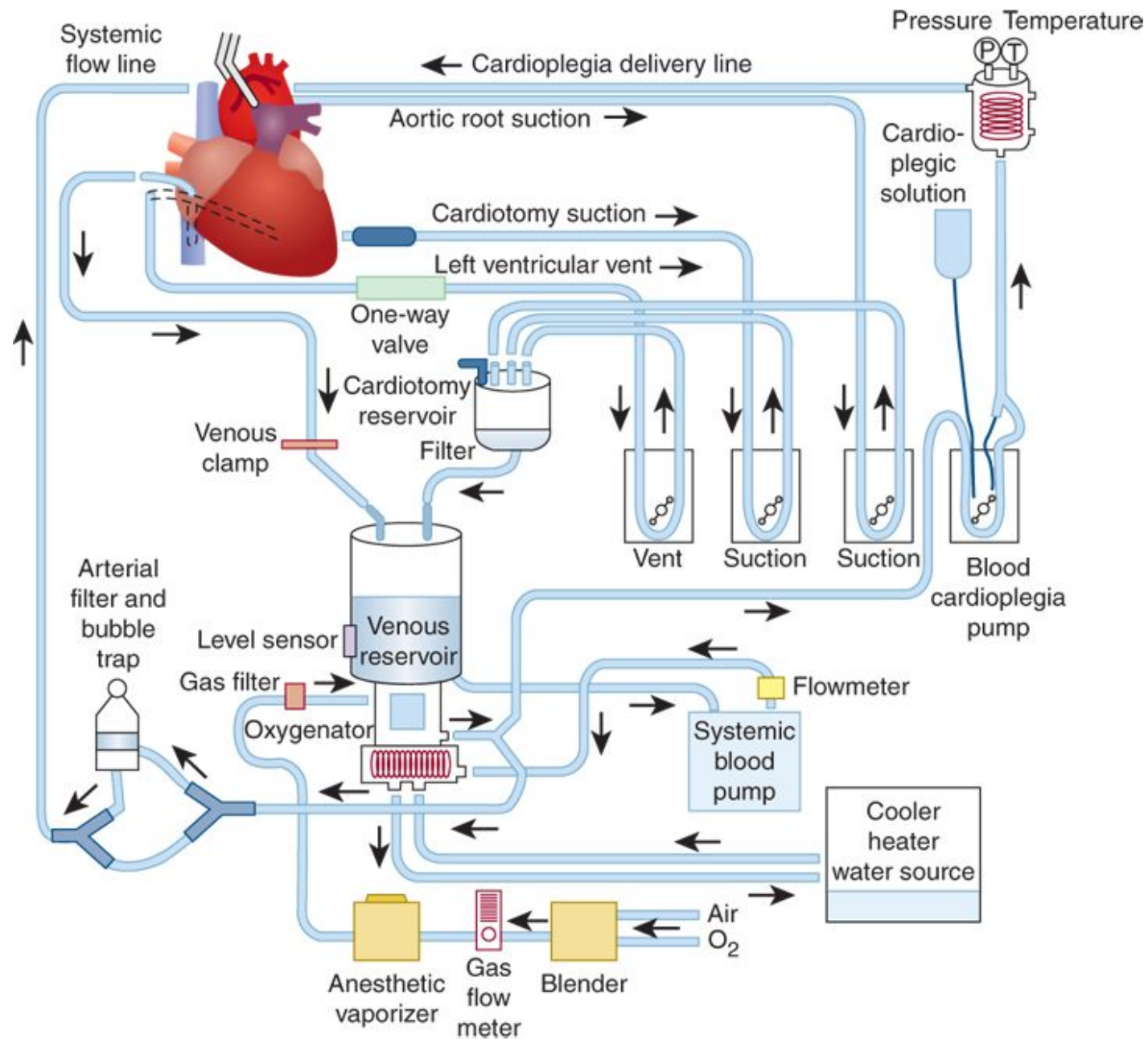
Ventricular Assist Device (VAD):

A VAD is a mechanical pump

To assist the pumping function of either the left or right ventricle.

Bridge-to-transplantation - Temporary support

Destination therapy - long-term support



**Thank
You**