**Physiology of Venous Return**

**Function of veins**
- Return blood to heart for re-oxygenation
  - and recirculation
- Storage of blood
  - 60-80% of resting blood volume sits in the venous system
- Maintain cardiovascular stability
  - through changes in capacitance
  - through sympathetic mediated smooth muscle tone

**Factors affecting venous return**
- **Intrinsic Factors**
  - Musculovenous Pump
  - Abdomino-thoracic Pump
  - Cardiac Pump
  - Intra-vascular volume
  - Venous resistance
  - Valve Integrity
  - Sympathetic tone
- **Extrinsic Factors**
  - Gravity
  - External Compression
  - Atmospheric Pressure

**1. Musculo–venous pump**

**2. Abdomino–thoracic pump**
- Upper Extremity Venous flow:
  - Increases with inspiration
  - Decreases with expiration
- Lower Extremity Venous flow:
  - Rib-cage breathing (no increase in intra-abdominal pressure)
    - Increases with inspiration
    - Decreases with expiration
  - Abdominal breathing (increase in intra-abdominal pressure)
    - Decreases with inspiration
    - Increases with expiration
Cardiac pulsations cause negative pressure in RA and RV, which have an aspiration effect on venous return.

At 4000 ml vascular volume, the circulatory filling pressure is 0 mmHg.

At 5000 ml vascular volume, the circulatory filling pressure is 7 mmHg.

Increasing venous resistance results in decreasing venous return.

Normal valves in the leg prevent reversed flow. Abnormal valves allow flow reversal.

Supine:
- RA Pressure: 0 mmHg
- Venous Capillary Pressure: 15 mmHg
- Gradient: 15 mmHg

Erect:
- RA Pressure: 0 mmHg
- Lower extremity Venous pressure: 15 + 80 mmHg
- Mean trans-capillary gradient remains the same.

Gravity affects venous return:
- Supine:
  - Net pressure: 0 mmHg
  - Venous Pressure Gradient
- Erect:
  - Net pressure: 0 mmHg
  - Venous Pressure Gradient

Ambulatory venous pressure
- Trend