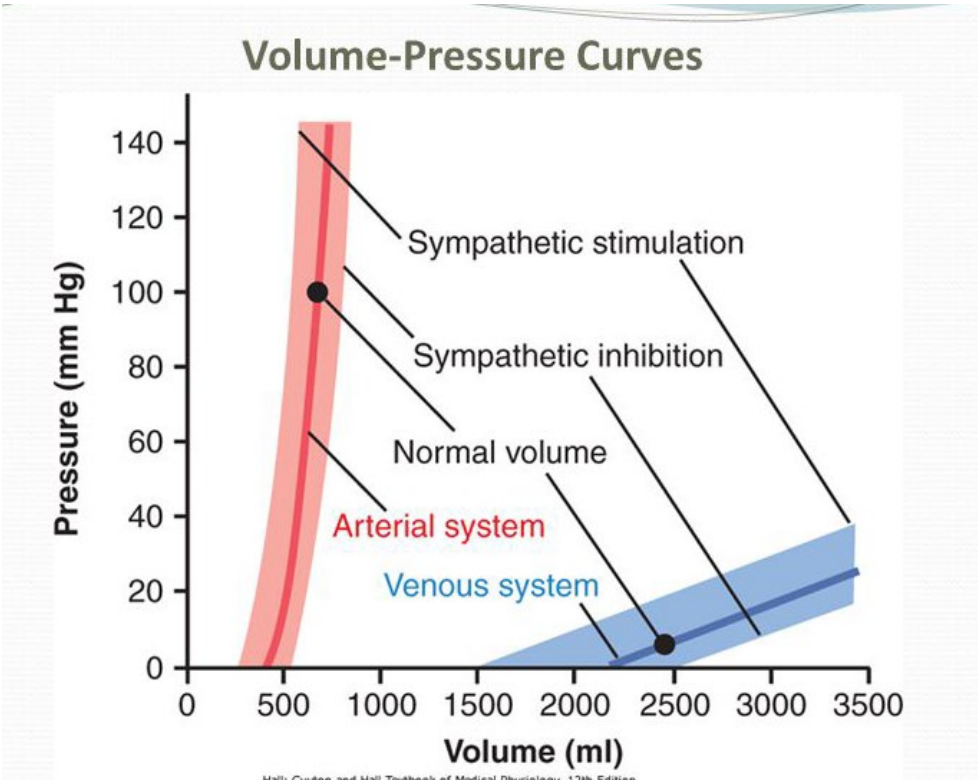
VASCULAR DISTENSIBILITY, AND FUNCTIONS OF THE ARTERIAL AND VENOUS SYSTEMS

- VASCULAR DISTENSIBILITY:
  - When the pressure in the arterioles is increased, this dilates the arterioles and therefore decreases their resistance, resulting in increased blood flow
  - The distensible nature of arteries allows them to accommodate the pulsatile output of the heart and as such provides almost completely smooth, continuous flow of blood
  - Calculated by:
    - Increase in volume / increase in pressure x original volume
    - Thus if one mmHg causes a vessel that originally contained 10 mL of blood to increase by 1mL, the distensibility would by 0.1 per mmHg
  - **Veins are on average, 8 times as distensible as the arteries** as walls of arteries are far stronger than those of veins

- VASCULAR COMPLIANCE:
  - It much more important to know the total quantity of blood that can be stored in a given potion of the circulation for each mmHg pressure rise than to know the distensibility of the individual vessels
  - THIS IS KNOWN AS VASCULAR COMPLIANCE OR CAPACITANCE
  - **Compliance = Increase in volume / increase in pressure**
  - **High compliance means large change in volume with minimal change in pressure.**
  - Very different to distensibility
  - Highly distensible vessel that has a slight volume may have far less compliance than a much less distensible vessel that has a large
    - **COMPLIANCE = DISTENSIBILITY X VOLUME**
  - Hence compliance of systemic vein is about 24 times corresponding artery, as it is 8 times as distensible and three times the volume

- VOLUME PRESSURE CURVES:
  - Arterial system:
    - Average adult, when filled with 750mL, pressure is approximately 100mmHg, when this **drops to 500mL of blood, drops to zero**
  - Venous sytem:
    - Volume normally ranges from 2500 – 3000, and tremendous change in volume is required to change the pressure
  - Effect of sympathetic stimulation:
    - Increases the pressure at each volume of the arteries or veins
    - Shifts large volumes of blood to the heart
    - With inhibition of sympathetic outflow, there is a decrease in pressure at each volume



- **DELAYED COMPLIANCE:**
  - Means that a vessel exposed to increased volume at first exhibits a large increase in pressure, but progressively delayed stretching of the vessel wall allows the pressure to return back toward normal
  - Hence, an increase in volume causes immediate elastic distension of the vein, but then the smooth muscle fibres of the vein begin to creep to longer lengths and their tensions correspondingly decrease
  - Valuable mechanism by which the circulation can accommodate much extra blood volume when necessary

- **ARTERIAL PRESSURE PULSATIONS:**
  - Were it not for the **distensibility of the arterial system, blood flow through the tissues would occur only during cardiac systole**
  - **Distensibility of the arterial system allows for blood flow during diastole**
  - However, the **compliance of the arterial tree reduces the pressure pulsations to almost zero, allowing tissue blood flow to be mainly continuous**
  - Difference between systolic and diastolic pressure is called the PULSE PRESSURE
  - Two major factors effect the pulse pressure:
    - **Stroke volume output**
    - **Compliance of the arterial tree**

- Therefore, the less compliant a vessel (arteriosclerosis), the greater the rise in pressure for a given stroke volume.
- **Stiff older vessels → increased pulse pressure**

- ABNORMAL PULSE PRESSURE:
  - **Aortic stenosis:**
    - Pressure pulse is decreased significantly because of diminished blood flow outward through the stenotic valve
  - **Aortic regurgitation:**
    - Blood that has just been pumped into the aorta flows immediately back in to the LV and so diastolic drops to near zero
  - **Patent ductus arteriosus:**
    - Great volume of blood pumped into the aorta by the LV flows immediately backward through PDA into **pulmonary circulation allow the diastolic pressure to fall to almost zero – i.e. wide pulse pressure.**

VEINS AND THEIR FUNCTIONS:

- VENOUS PRESSURES:
  - Blood from all the systemic veins flows into the right atrium, therefore the pressure in the right atrium is called the CENTRAL VENOUS PRESSURE
  - Right atrial pressure is regulated by a balance between:
    - Ability of the heart to pump blood out of the RA and RV into the lungs
    - Tendency for blood to flow from the peripheral veins into the right atrium
  - As a result, weakness of the heart elevates RA pressure
  - Likewise, any effect that causes rapid inflow of blood into the RA from the peripheral veins elevates the right atrial pressure
    - Increased blood volume
    - Increased large vessel tone
    - Arteriolar dilatation
  - Normal right atrial pressure (CVP) is about 0mmHg:
  - Can increase to 20-30 mmHg:
    - Serious heart failure
    - Massive blood transfusion

- VENOUS RESISTANCE AND PERIPHERAL VENOUS PRESSURE:
  - Large veins, when distended, have almost zero resistance
  - However, most of the large veins that enter the thorax are compressed at many points by the surrounding tissues:
    - Abdominal pressure collapse of abdominal veins

        - Arm veins are compressed by their sharp angulation over the ribs
        - Atmospheric collapse in the neck veins
    - When right atrial pressure rises, it needs to overcome the collapsed points before raising peripheral venous pressure. This normally occurs at 4-6mmHg
    - Abdominal pressure can rise by 15-30mmHg as a result of pregnancy, large tumours or ascites, thereby causing a back pressure in the leg veins

- EFFECT OF GRAVITATIONAL PRESSURE ON VENOUS PRESSURE:
    - The pressure that results from the weight of the water is called gravitational pressure or hydrostatic pressure
        - Occurs because of the weight of the blood in the vessels
        - **Theoretically, pressure in the veins of the feet is 90mmHg**
    - Venous pressure can be calculated by both hydrostatic pressure added to peripheral venous pressure related to compression points
    - Similar effect noted with arterial pressure, with increased pressure in the feet

- VENOUS VALVES:
    - Were it not for valves in the veins, the hydrostatic pressure effect would cause the venous pressure in the feet to always be about +90mmHg
    - Valves are arranged so that the direction blood flow can be only toward the heart
        - When muscles tighten, veins compressed and blood flows toward the heart, with valves preventing back flow
        - Known as the VENOUS PUMP or the MUSCLE PUMP
        - Under normal circumstances, the venous pressure is the walking adult is normally less than 25mmHg
        - If stands still ->venous pooling occurs, with fluid leak from the capillaries and diminished blood volume
    - Venous valve incompetence can cause varicose veins:
        - Stretching veins increases their cross-sectional area without increasing the size of the valve ->eventually leads to bulbous protrusions, particularly the lower leg
        - Venous and capillary pressures become very high, leading to rapid onset oedema in standing patients
            - Inadequate diffusion of nutritional nutrients ->gangrenous or ulcerating lesions result

- BLOOD RESERVOIR FUNCTION OF VEINS:
    - Specific blood reservoirs:
        - Spleen:

        - Red cells trapped in the trabecular mesh of the red pulp, and then can be released as high haematocrit blood when required
    - Liver (several hundred mL)
    - Large abdominal veins (300mL)
    - Venous plexus beneath the skin