Blood Flow

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Characteristic of blood Flow

- the blood flow at any point in the circulatory system is the volume of blood that passes that point during a unit of time.
- It is normally measured in milliliters per minute or liters per minute.
- Blood flow is highest in the pulmonay artery and the arota, where these blood vesels leave the heart.
- The flow at this point is **cardiac** output, is between 3.5 and 5 liter/min in the normal adult a rest.

Characteristic of blood Flow

- In the capilaries, on the other hand, the blood flow can be so slow that the travel of individual blood cell can be observed under a microscope.
- From the cardiac ouput or the blood flow in a given vessel,a number of other characteristic varaibles can be measured.
- Cardiac output divided by heart beat per minute give the amount of blood that is ejected during each heart beat , or the **stroke volume.**

Characteristic of Blood Flow

- If the total amount of blood circulation is known, and this volume is dvided by the cardiac output, the **mean circulation time** is obtained.
- From the blood flow through a vessel, divided by the cross-sectional area of the vessel, the **mean velocity** of the blood at the point of measurement can be calculated.

Characteristic of Blood Flow

- In the arteries,blood flow is pulsatile.
- In fact, in some blood vessels a reversal of the flow occur during certain part of the heart beat cycle.Because of the elasticity of their wall, the blood vessel tend to smoothout the pulsations of the blood flow and blod pressure.
- Both pressure and flow are grates in arota, where blood leaves the heart.
- Blood flow is the function of blood pressure and flow resistance of the blood vessels in the same way as electrical current flow depends upon the voltage an resitance.

Characteristic of Blood Flow

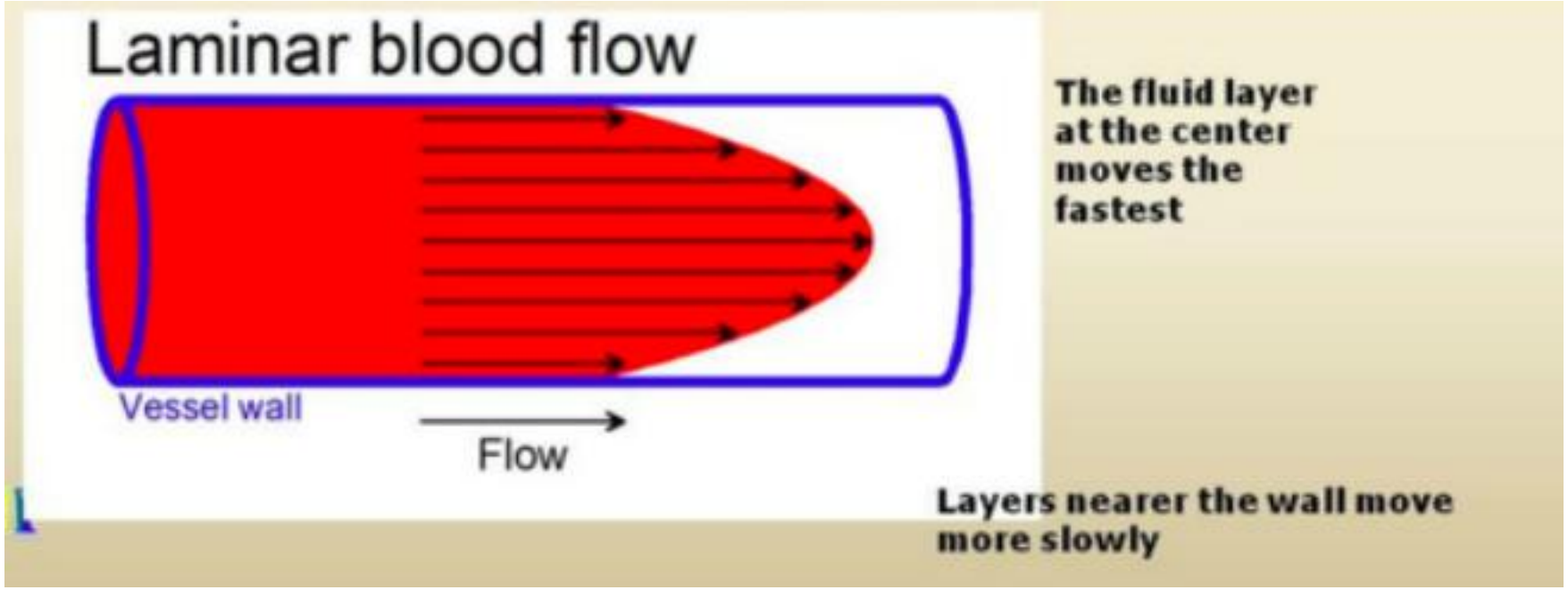
- The flow resistance of the capillary bed , however , can vary over a wide range.
- For instance, when exosed to low temperature or under the influence of certain drugs(e.g.nicotine), the body reduces the blood flow through the skin by **vascoconstriction (**narrowing**)** of the capillaries.
- Heat,excitement, or local inflammation, among other things, can cause vasodilation (widening) of capillaries, which increases the blood flow, at least locally

Characteristic of Blood Flow

- the velocity of blood flowing through a vessel is not constant throughout the cross section of the vesselbut is function of the distance from the wall surface.
- A thin layer of blood actually adhres to the wall, resulting in zero velocity at this place , whereas highest velocity occurs at the center of the vessel.
- the resulting “velocity profile” is shown in figure.
- Some blood flow meters do not actually measure the blood flow but measure the mean velocity of the blood.

Characteristic of Blood Flow

- If , however , the cross sectional area of the blood vessel is known, these device can be calibrated directly in term of blood flow.



Blood Flow Measurement

- An adequate blood supply is necessary for all organs of the body;in fact , an impaired supply of blood is the cause of various diseases.
- The ability to measure blood flow in the vessel that supplies a particular organ would therefore be of great elp in diagnosing such diseases.
- Unfortunately,blood flow is a rather elusive varaible that cannot be measured easily.
- The rate of flow of aliquid or gas in a pipe is expressed as the volume of the substance that passes through the pipe in a given unit of time.

Blood Flow Measurement

- Flow rates are therefore usually expressed in liters per minutes or millileters per minutes.
- Practically all blood flow meters currently used in clinical and research applications are based on one of the following physical principles:
  - Electromagnetic Induction
  - Ultrasound transmission or reflection
  - Thermal convection
  - Radiographic principles
  - Indicators (dye or thermal) dilution

Magnetic blood flow meter

- When an electric conduction is moved through a magnetic field a Voltage is induced in conductor proportional to the velocity of its motion'
- The same principal is applicable when the moving conductor is not a wire,but rather a column of conductive fluid that flows through a tube located in the magnetic field.
- Figure below show this principle is used in magnetic blood flow meters.

Magnetic blood flow meter

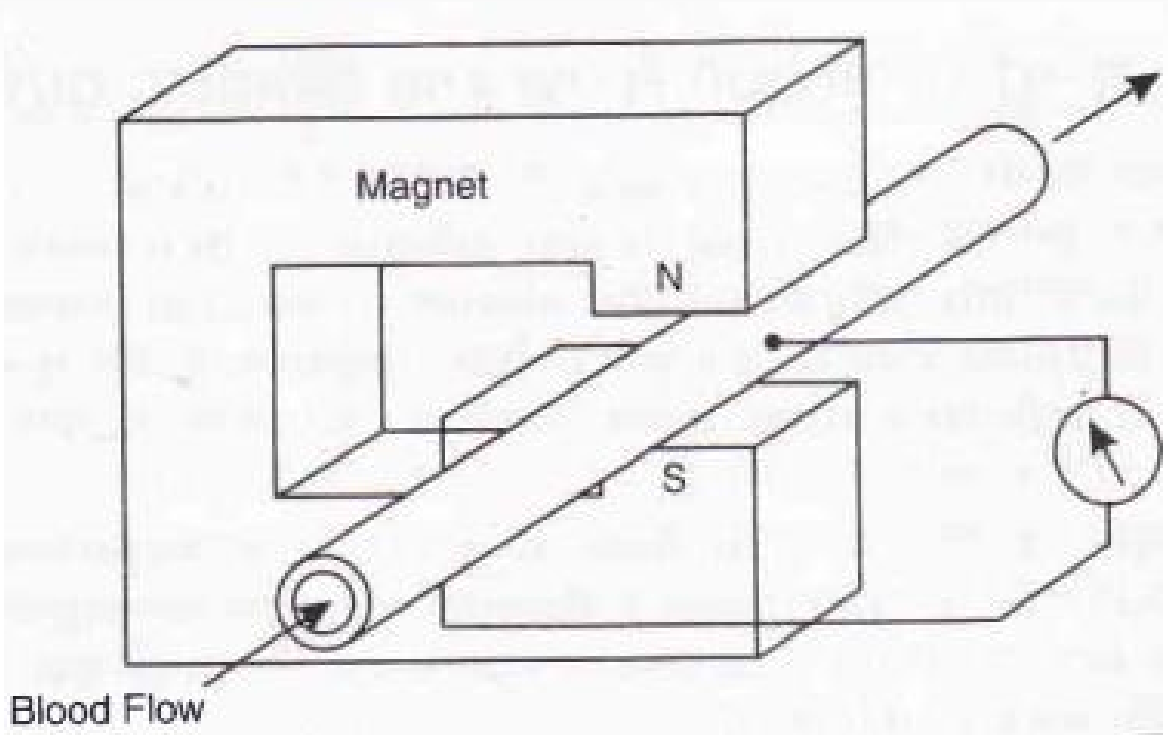


Fig. 5.14. Magnetic blood flow meter principle

Magnetic blood flow meter

- A permanent magnet or electromagnet positioned around the blood vessel generates a magnetic field perpendicular to the blood flow.
- The induced voltage in the moving blood column is measure with stationary electrodes located on opposite sides of blood vessel and perpendicular to the direction of the magnetic field.

Ultrasonic Blood Flow meter

- In an ultrasonic blood flow meter, a beam of ultrasonic energy is used to measure the velocity of flowing blood. There are two different ways of ultrasonic blood flow meter, they are transit time and doppler type.

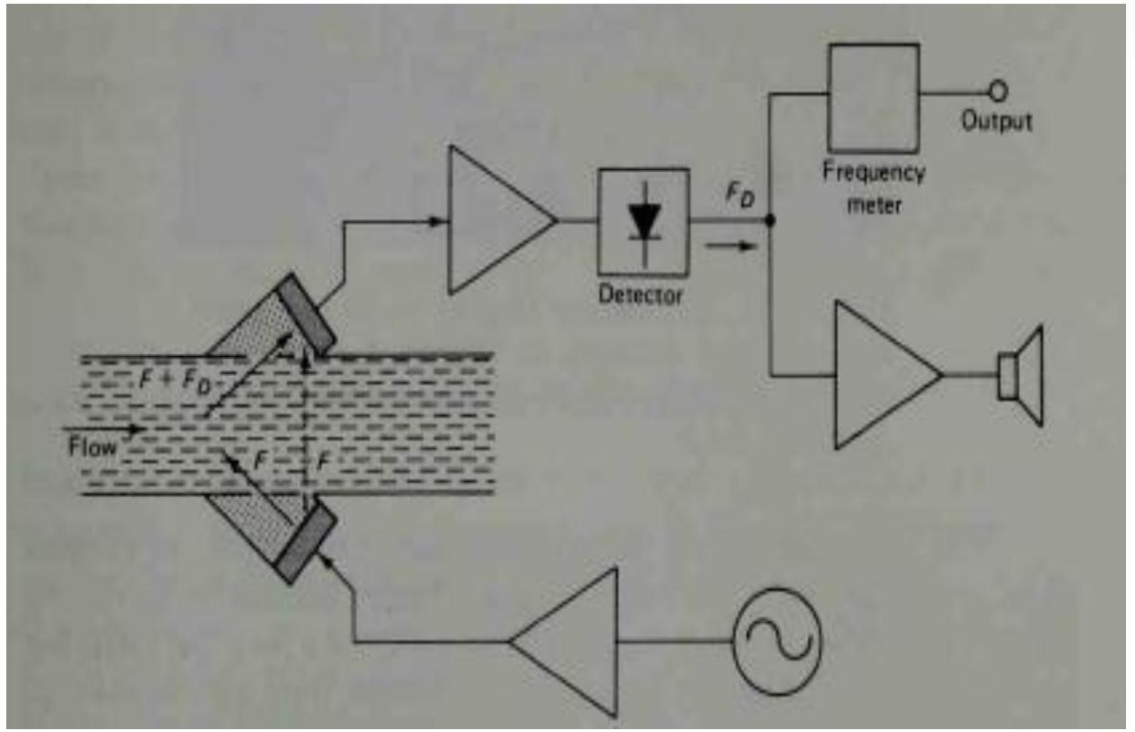
Transit time:

- In transit time ultrasonic blood flow meter, a pulsed beam is directed through a blood vessel at a shallow angle and it transmit time is then measured. When the blood flows in the direction of the energy transmission, the transit time is shortened, if it flows in the opposite direction, the transit time is lengthened.

Ultrasonic Blood Flow meter

Doppler type:

- The block diagram of ultrasonic blood flow meter, Doppler type is given below.
- An oscillator, opening at a frequency of several megahertz (MHz), excites a piezoelectric transducer. The piezoelectric transducer is coupled to the wall of an exposed blood vessel and sends an ultrasonic beam with a frequency F into the following blood.



Ultrasonic Blood Flow meter

- A small part of the transmitted energy is scattered back and is received by a second transducer arranged opposite the first transducer. Because the scattering occurs mainly as a result of the moving blood cells, the reflected signal has a different frequency due to the doppler effect.
- The transmitted frequency is either F+FD or F-FD, depending on the direction of the blood flow. When the blood flow is in same direction to the beam, then the frequency is F+FD, if the blood is in opposite direction to the beam, then the frequency is F-FD.

Ultrasonic Blood Flow meter

- The doppler component FD is directly proportional to the velocity of the flowing blood. A fraction of the transmitted ultrasonic energy, with the frequency being unchanged.
- The measure of blood flow can be obtained with the help of frequency meter. The doppler signal of the pulsating blood flow can also be heard with the help of loud speaker.