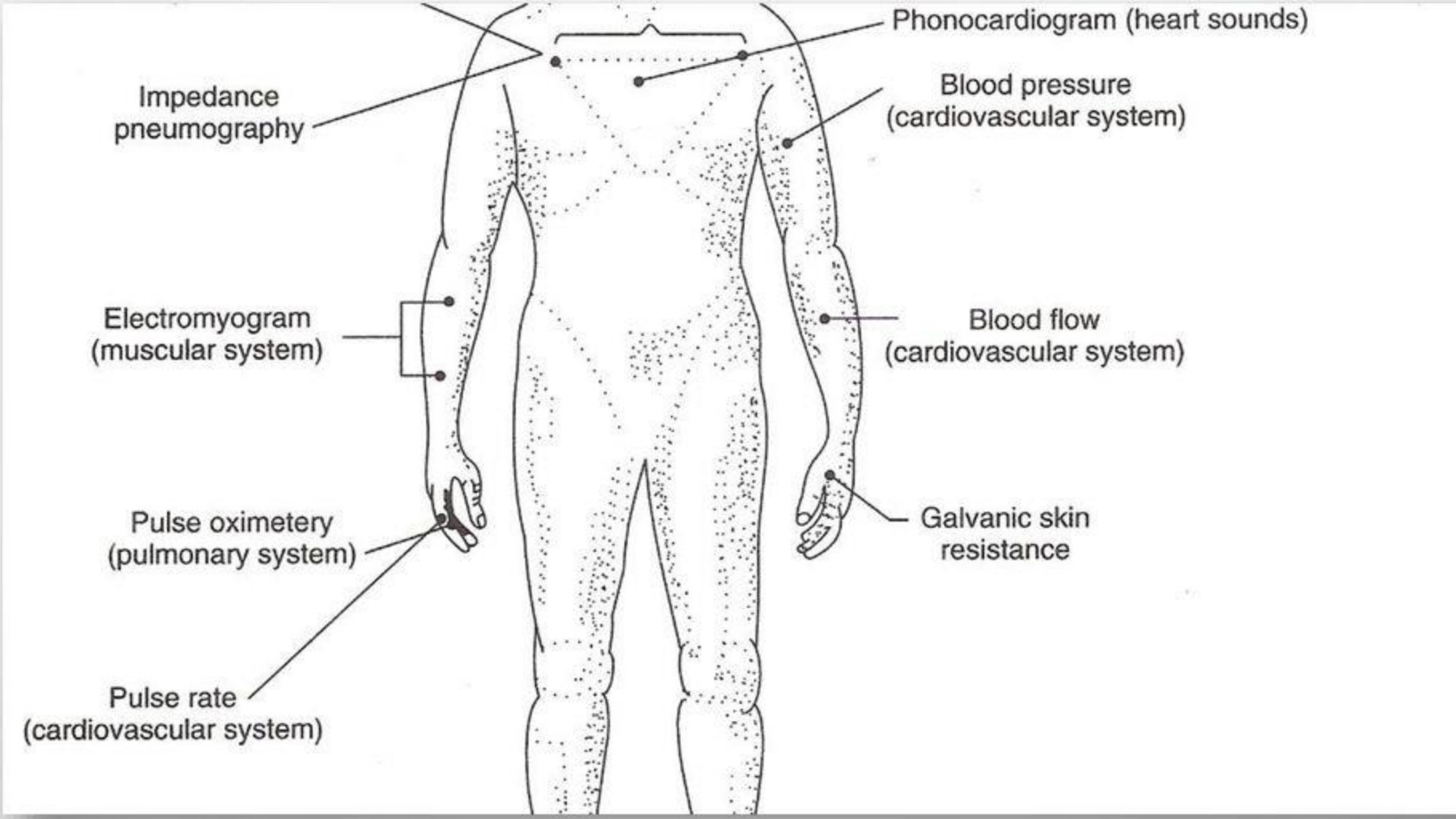
Biomedical Signals

- Biomedical signals are those signals (phenomenon that conveys information) which are used primarily for extracting information on a biological system under investigation.

Sources of Biomedical Signals

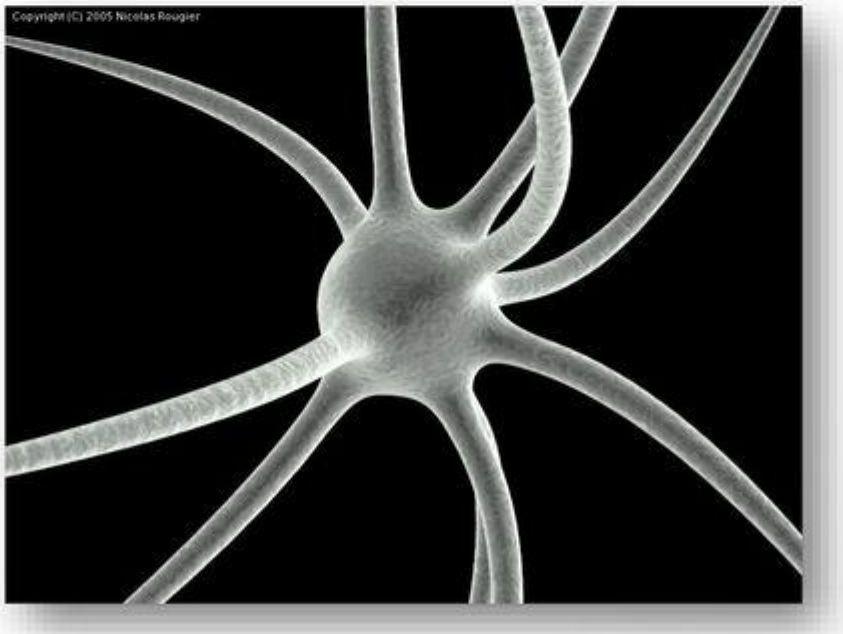


Source of Biomedical Signals

- ***Bioelectric Signals***
- ***Bioacoustics Signals***
- ***Biomechanical Signals***
- ***Biochemical Signals***
- ***Biomagnetic Signals***
- ***Bio-optical Signals***
- ***Bio-impedance Signals***

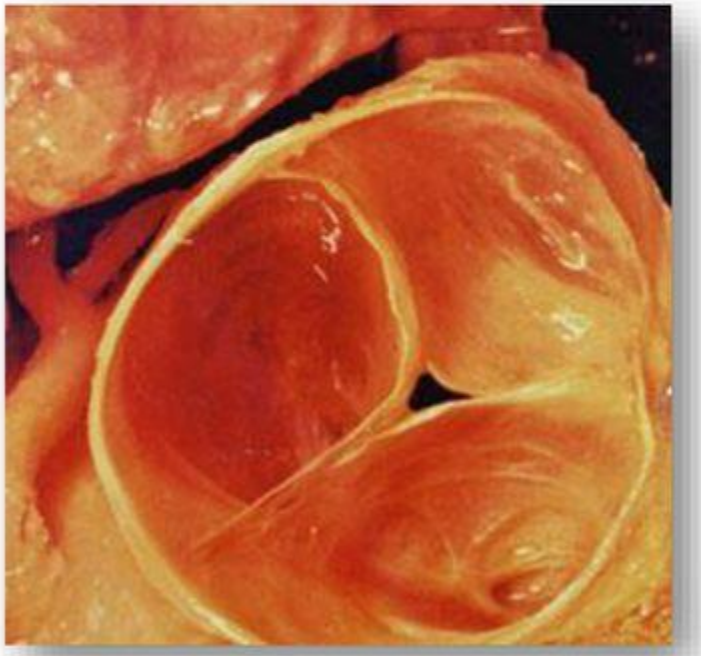
Sources of Biomedical Signals

- Bioelectrical
  - Membrane potentials generated by nerve and muscle cells.
  - Eg. electrocardiogram, electromyogram signals etc.



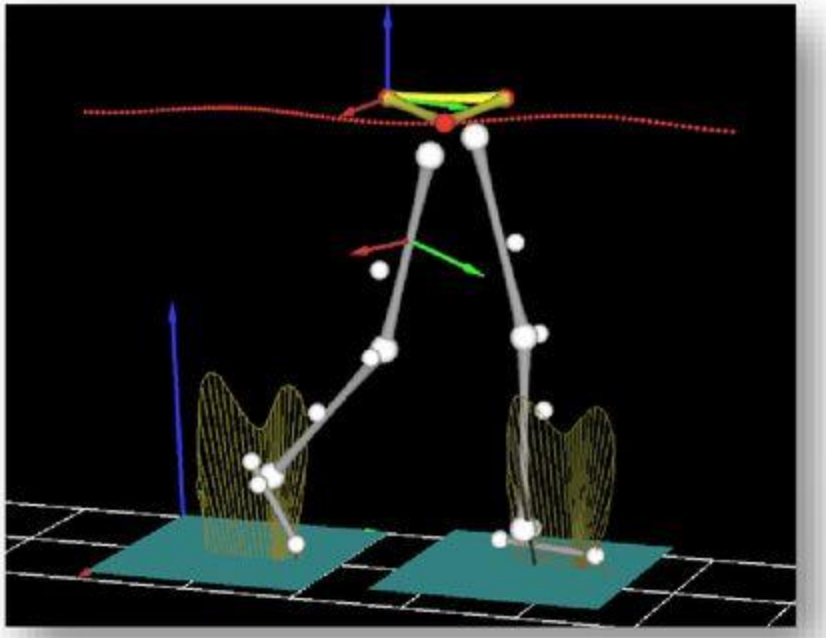
Sources of Biomedical Signals

- Bioacoustics
  - Acoustic signals created by biomedical phenomena.
  - Eg. sound from heart valves, air flow in the lung etc.



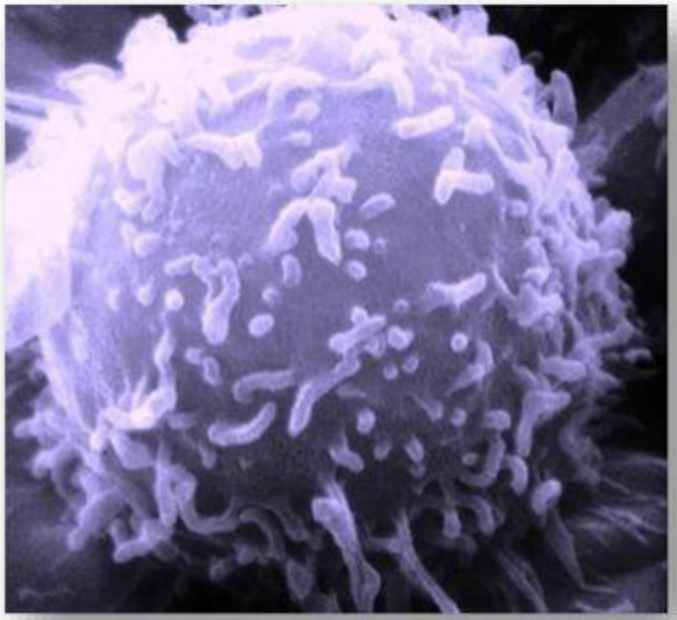
Sources of Biomedical Signals

- Biomechanical
  - Originate from mechanical functions of biological system.
  - Eg. displacement, pressure and flow signals



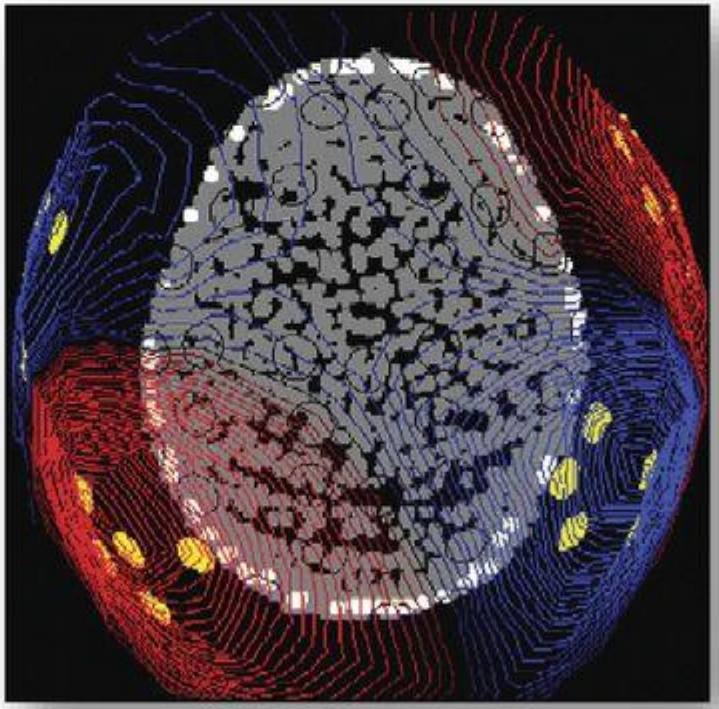
Sources of Biomedical Signals

- Biochemicals
  - Resultant of chemical measurement from living tissues or samples.
  - Eg. Concentration of various ions in the blood.



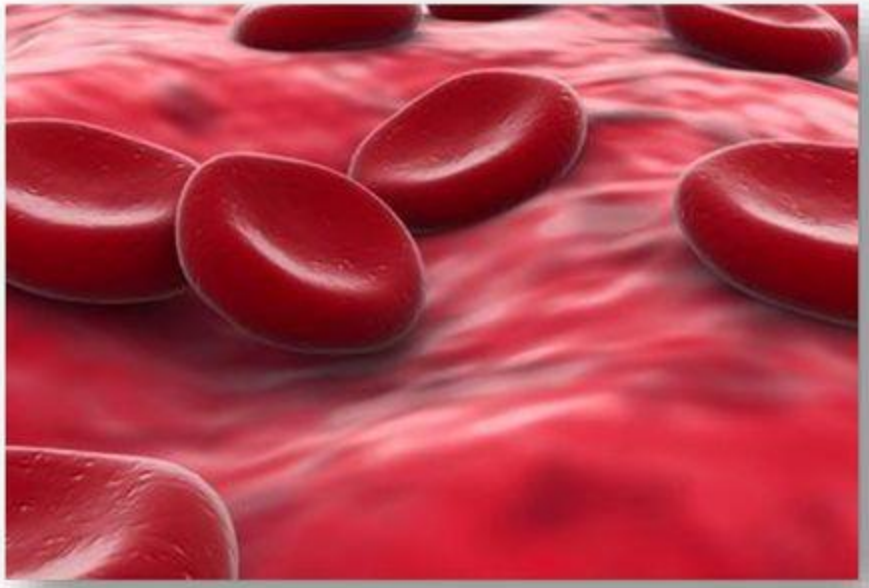
Signals

- Biomagnetics
  - Weak magnetic signals produced by various organs.
  - Eg. MEG signals from the brain.



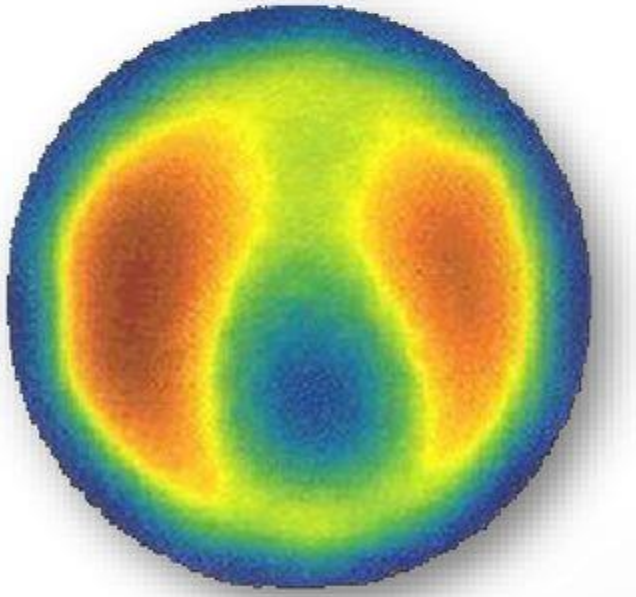
Sources of Biomedical Signals

- Bio-Opticals
  - Generated as a result of optical functions from the biological system.
  - Eg. Modified IR absorption due to blood oxygenation.



Sources of Biomedical Signals

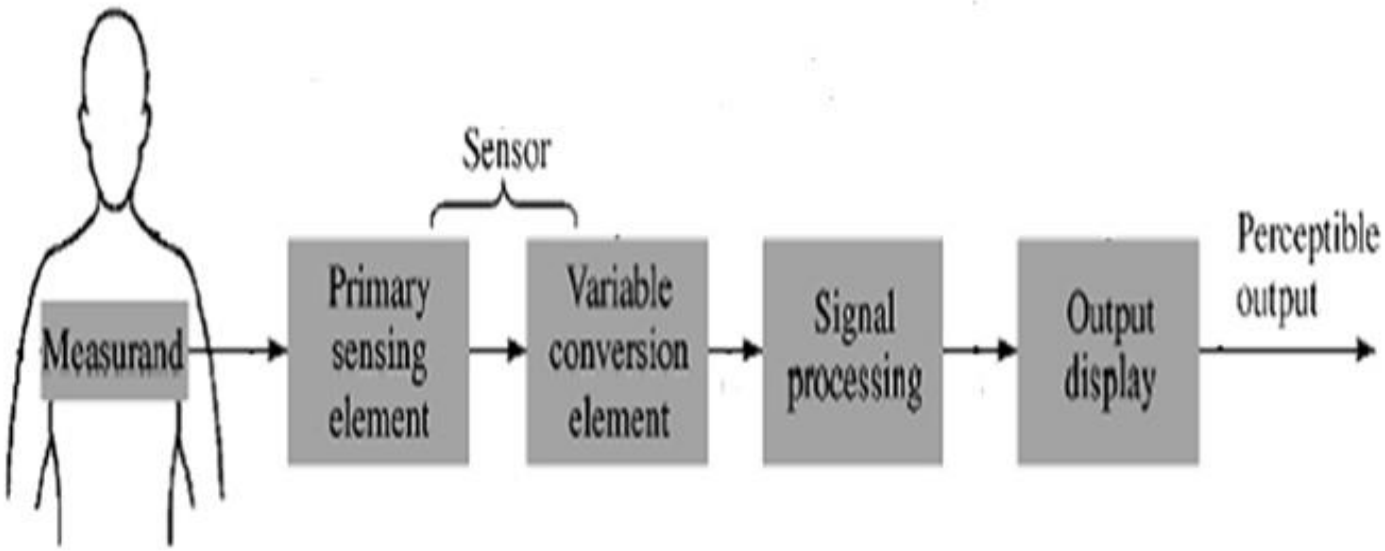
- Bioimpedance
  - Tissue impedance that gives information regarding its composition, blood volume etc.
  - Eg. Galvanic skin resistance, respiratory rate etc



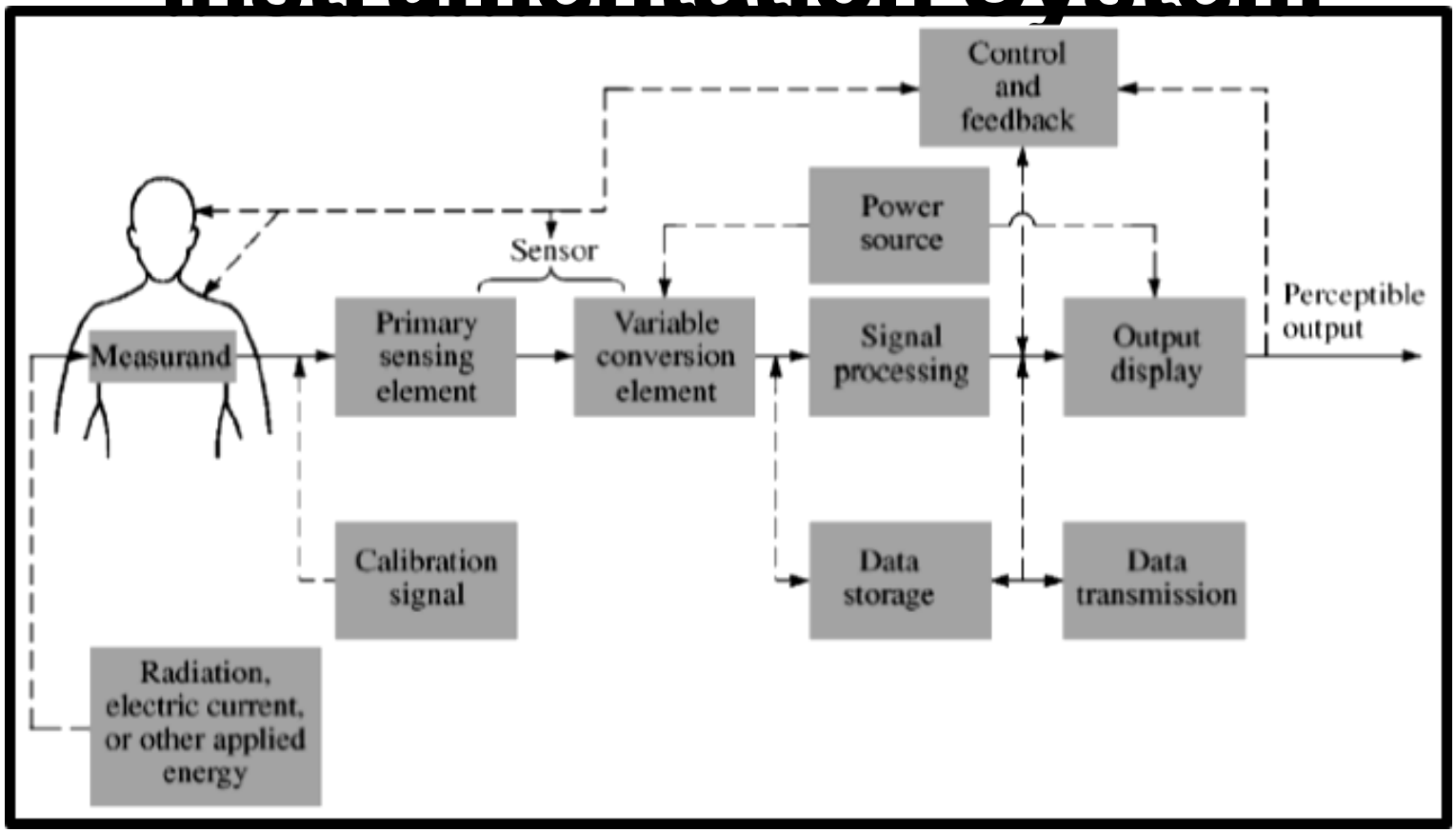
Bioelectric signals and their

Biolelectric signal	Frequency range (Hz)	Voltage range (µV)	Electrodes used	Origin
Electrocardiogram	0.05 to 100	10 to 5000 covers fetal range	Surface electrodes are used with jelly, paste or cream. Needle electrode are less noisy	Heart muscles
Electroencephalogram	0.1 to 100	2 to 200	Surface and needle electrode	Neuronal activity of the brain
Cerebral potentials (intracranially recorded)	Pulse duration 0.6ms to 0.1s	10 to 100000	Deep needle electrodes	Cerebrum of the brain
Electromyogram	5 to 2000	20 to 5000	Surface or needle electrodes	Skin muscles
Electrogastrogram	0.05 – 0.2	10 – 350	Surface electrodes	Peristaltic movements of the gastrointestinal tract
Electroretinogram	0.01 to 200	0.5 – 1000	Corneal electrodes	Retina of the eye
Electrooculogram	0.1 to 100	10 to 3500	Miniature surface electrodes	Corneal-retinal potential variations

Basic Instrumentation System



Generalized Medical instrumentation System



Components of Medical Instrumentation System

- Measurand
- Sensor / Transducer
- Signal Conditioning
- Output Display
- Auxiliary Components

Measurand

- The physical quantity, property, or condition that the system measures is called measurand.
- The accessibility of the measurand is important because it may be:
  - Internal (Blood Pressure)
  - On the Body Surface (Electrocardiogram)
  - Emanate from the body (Infrared Radiation)
  - Derived from Tissue Sample (such as Blood or a Biopsy)

Cont…

- Most medically important measurands can be grouped in the following groups:
  - Biopotential,
  - Pressure,
  - Flow,
  - Dimensions (Imaging),
  - Displacement (Velocity, Acceleration, And Force),
  - Impedance,
  - Temperature, And
  - Chemical Concentrations
- The measurand may be localized to a specific organ or anatomical structure.

Sensor

- The **transducer** is defined as a device that converts one form of energy to another.
- A **sensor** converts a physical measurand to an electric output.
- The sensor should respond only to the form of energy present in the measurand, to the exclusion of all others.
- The sensor should non invasive and minimally invasive.

Signal Conditioning

- Simple signal conditioners may only amplify and filter the signal or merely match the impedance of the sensor to the display.
- Often sensor outputs are converted to digital form and then processed by specialized digital circuits or a microcomputer.
- For example, signal filtering may reduce undesirable sensor signals.
- It may also average repetitive signals to reduce noise, or it may convert information from the time domain to the frequency domain.

Output Display

- The results of the measurement process must be displayed in a form that the human operator can perceive.
- The best form for the display may be:
  - Numerical
  - Graphical,
  - Discrete or Continuous,
  - Permanent or Temporary
  - Visual / Hearing

Auxiliary Components

- A **calibration signal** with the properties of the measurand should be applied to the sensor input or as early in the signal-processing chain as possible.
- Many forms of **contro** l and **feedback** may be required to elicit the measurand, to adjust the sensor and signal conditioner, and to direct the flow of output for **display , storage** or **transmission.**
- The **control** and **feedback** may be **automatic** or **manual** .

Cont…

- Data may be **stored** briefly to meet requirements of signal conditioning or to enable operator to examine the data that precede alarm conditions. Or data may be **stored** before signal conditioning, so that different processing schemes can be utilized.
- Conventional **principles of communication** can often be used to **transmit data** to remote displays at nurses' stations, medical centers, or medical data-processing facilities.