INTRODUCTION TO BIOMEDICAL SIGNALS

ECE 331 – INTRODUCTION TO BIOMEDICAL ENGINEERING

Monday, November 10, 2025

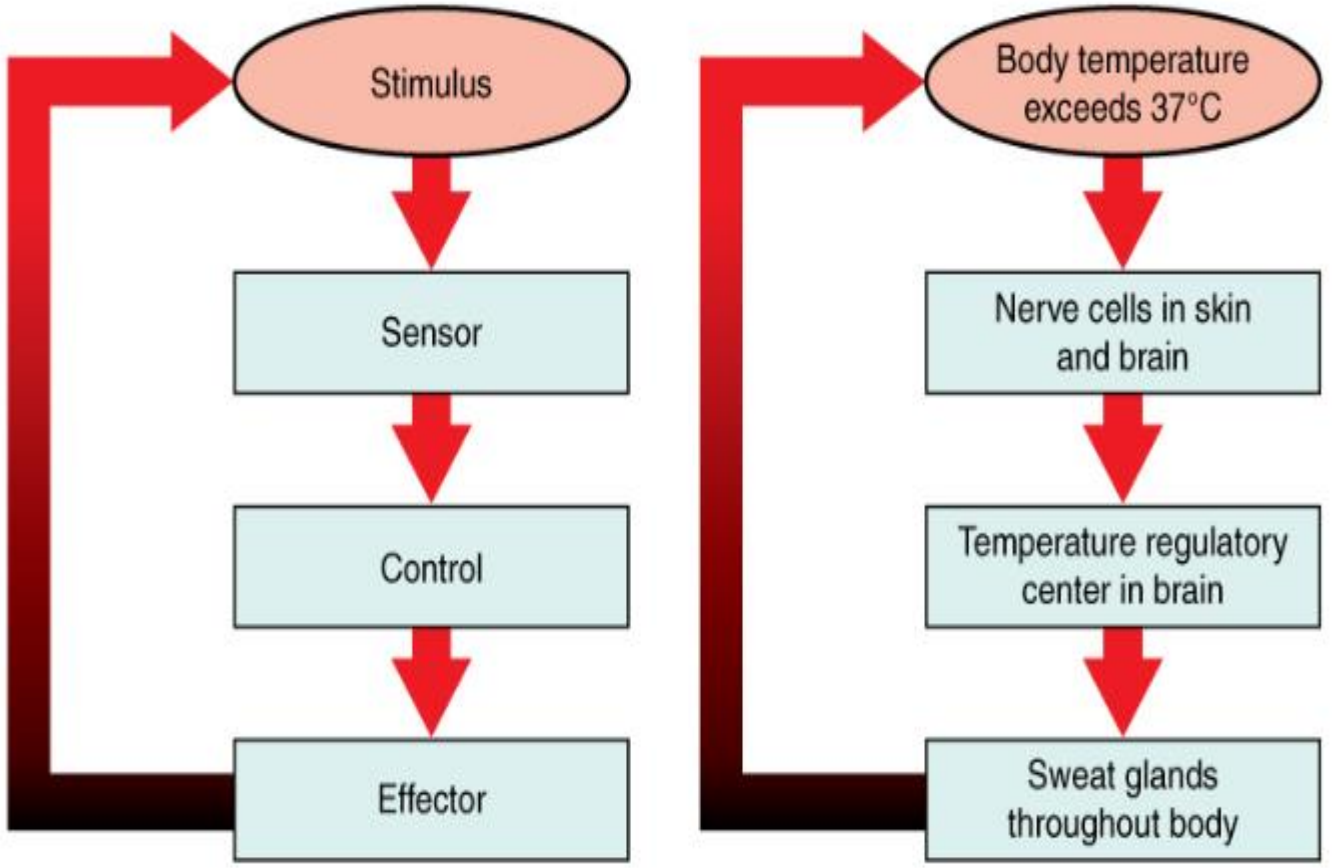
INTRODUCTION

1. **Human body** includes several systems. Each system is made up of several subsystems that carry on many physiological processes.
2. **Physiological processes** are complex phenomena, including nervous or hormonal stimulation and control,
3. **Inputs and outputs** to physiological processes are in form of physical action that could be neural or chemical.
4. **Most physiological processes** are accompanied by signals of several types that reflect their mechanical, electrical, or chemical activities.

CONTROL WITH NEGATIVE FEEDBACK

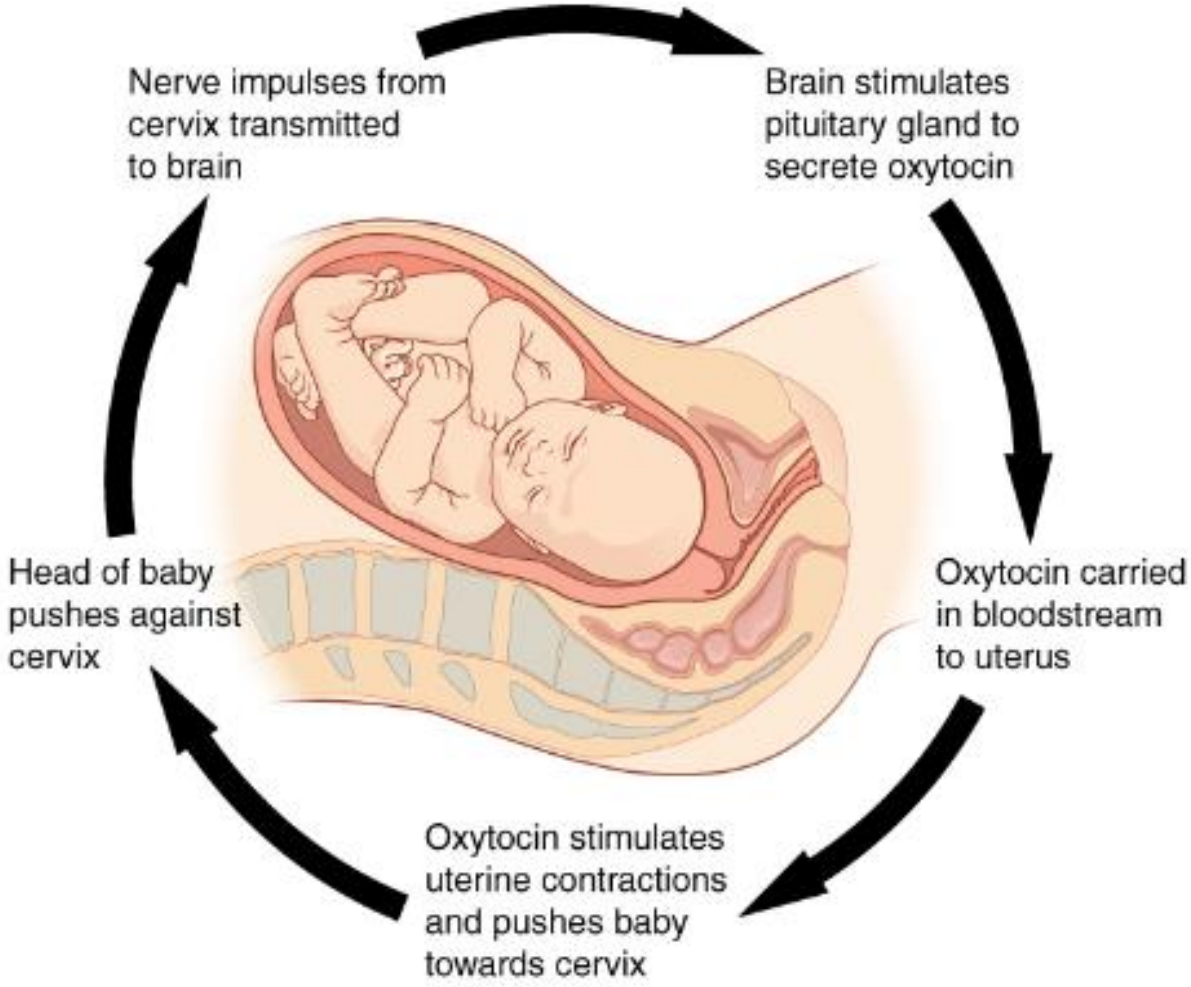
A negative feedback biological system has three basic components, i.e

1. **Sensor** monitors a physiological value and sends information to the controller
2. **Controller** compares the value to the normal range and takes the decision to effect change.
3. **Effector** causes a change to reverse the situation and return the value to the normal range.



CONTROL WITH POSITIVE FEEDBACK

1. **Positive feedback** intensifies a change in the body's physiological condition rather than reversing it.
2. **In Positive feedback, deviation from the normal range results in more change**, and the system moves farther away from the normal range.



TYPES OF SIGNALS IN HUMAN PHYSIOLOGICAL PROCESSES

1. Signals in human physiological processes are of two types , i.e chemical and electrical.
2. **Chemical signals** are in the form of hormones
3. **Electrical signals** are in the form of electric potential or electric current.

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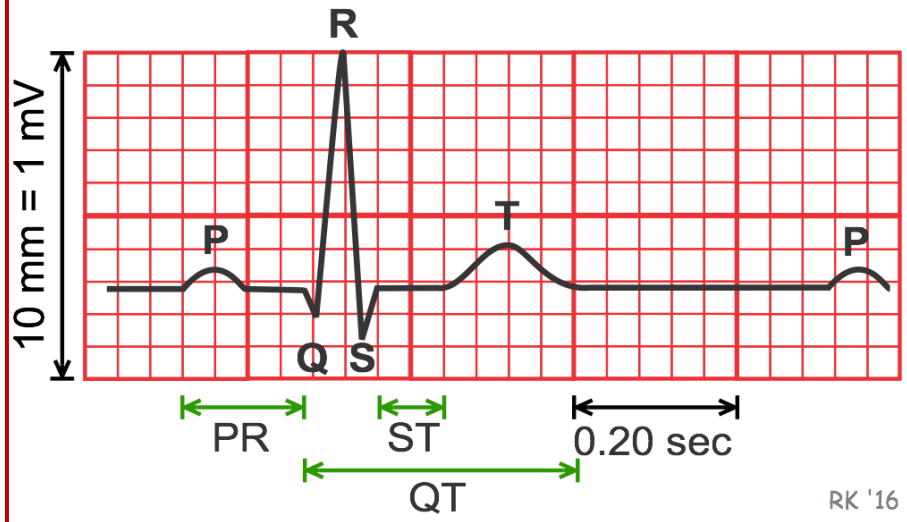
WHAT IS A BIOMEDICAL SIGNAL?

1. **Biomedical signal** is any measurement or observation that conveys information about a biological system or state.
2. **It is typically a voltage or current** that varies with time.
3. **Purpose:**
   - Diagnosis of diseases
   - Monitoring physiological state (e.g., during surgery)
   - Designing therapeutic devices (e.g., pacemakers)
   - Prosthetic control



(a) Example of Bioelectric Signal – Electrocardiogram (ECG)

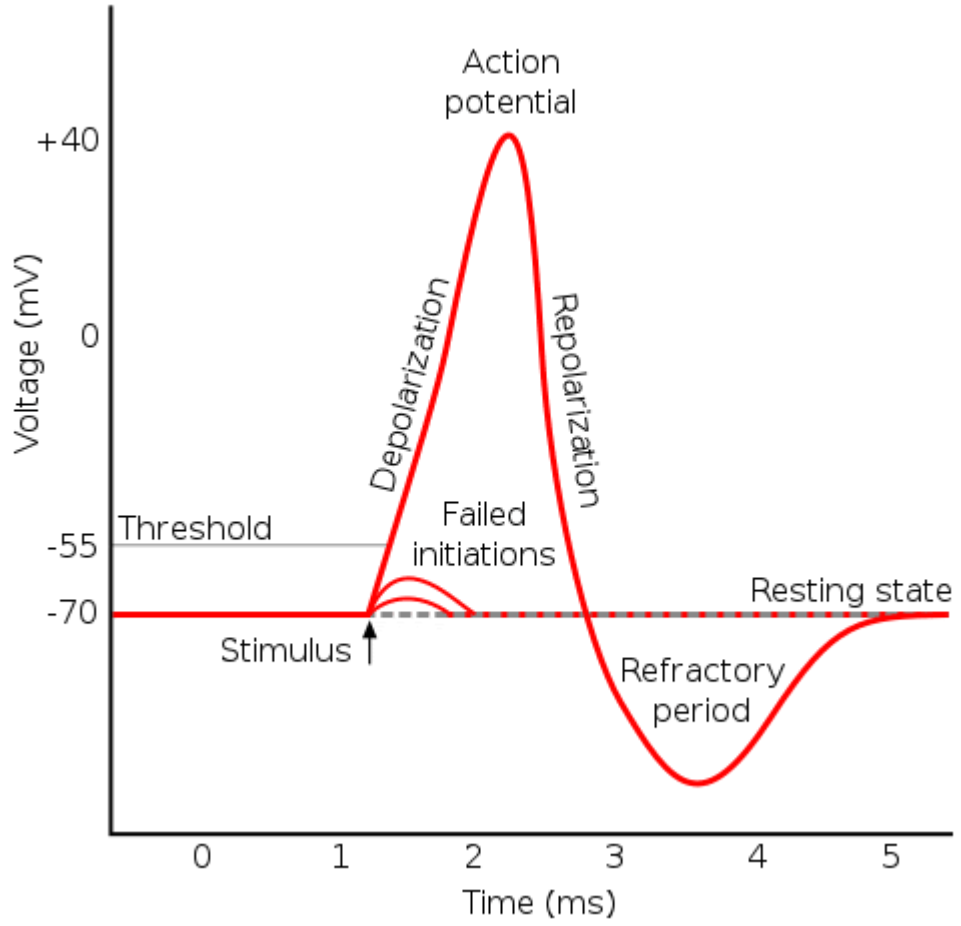
CLASSIFICATION OF BIOMEDICAL SIGNALS

Biomedical signals are usually categorized according to the nature of their source as follows:

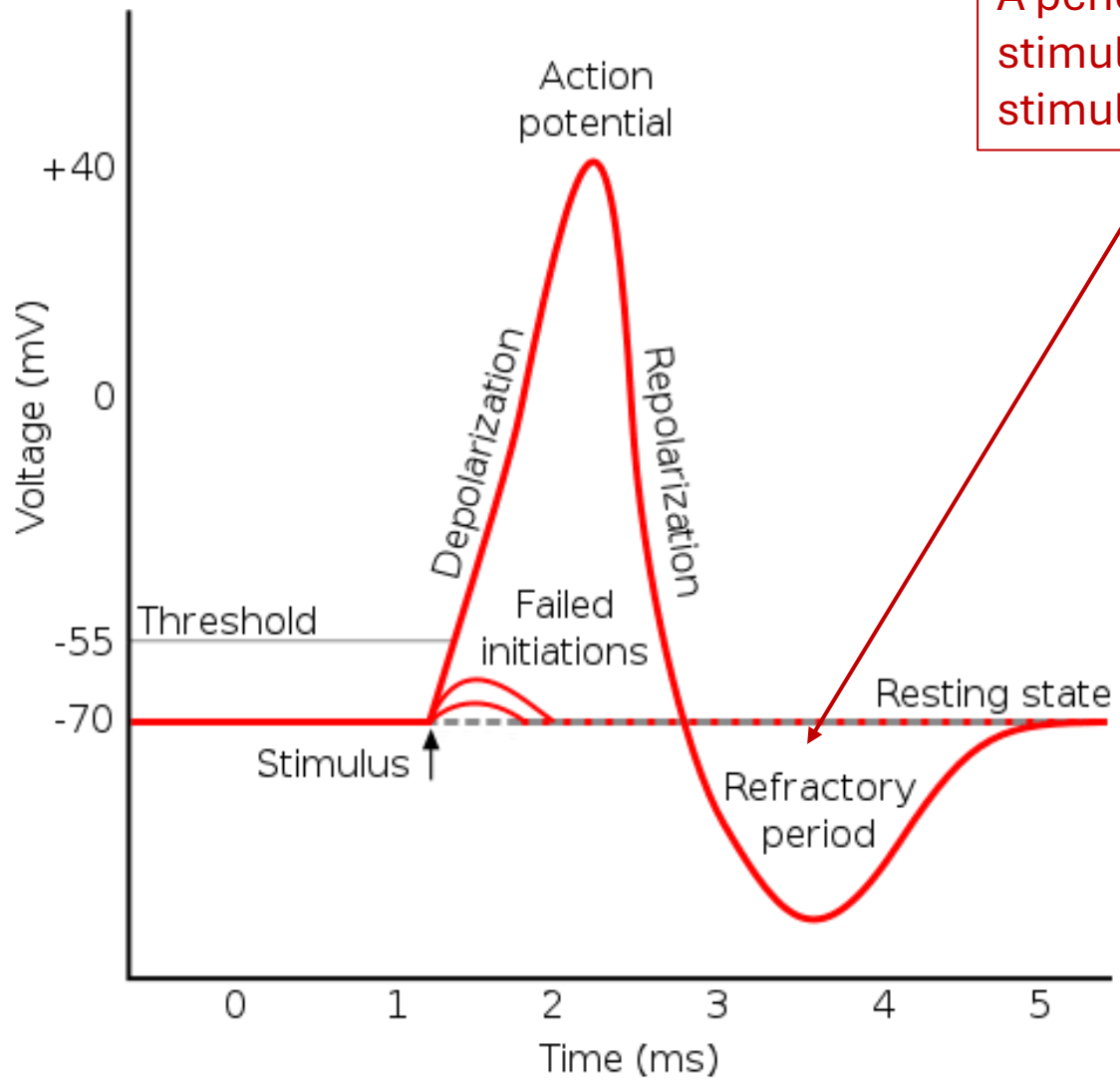
1. **Bioelectric:** Generated by the body's electrical activity (e.g., ECG, EEG, EMG).
2. **Bioimpedance:** Measure of tissue resistance to current flow (e.g., Respiration).
3. **Biomechanical:** Generated by mechanical functions (e.g., Blood Pressure, Heart Sounds).
4. **Biochemical:** Chemical concentrations (e.g., Blood Glucose, pH).

SOURCE OF BIOELECTRIC SIGNALS

1. **Nerve and muscle cells generate bioelectric signals** that are the result of electrochemical changes within and between cells.
2. **If a nerve or muscle cell is stimulated by a stimulus** that is strong enough to reach a necessary threshold, the cell will generate an action potential.
3. **The action potential**, which represents a brief flow of ions across the cell membrane, can be measured with intracellular or extracellular electrodes.



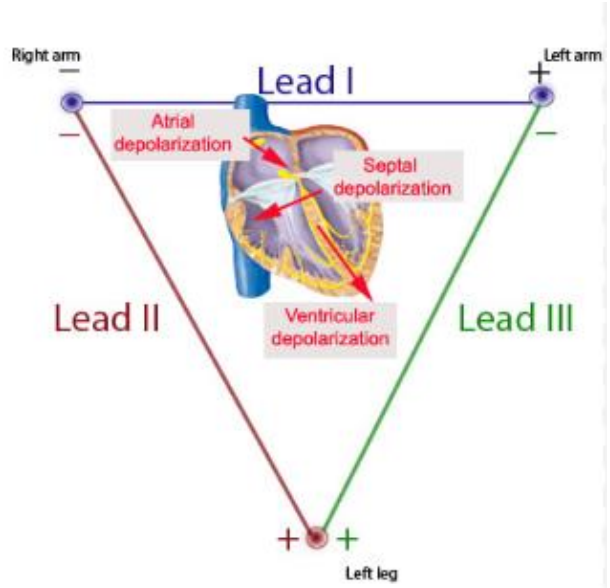
Refractory period :
A period immediately following a stimulus during which further stimulation has no effect.



EXAMPLES OF BIOLECTRIC SIGNALS /1

Examples of bioelectric signals are:

1. **Electrocardiogram:** A simple, non-invasive test that records the electrical activity of the heart.

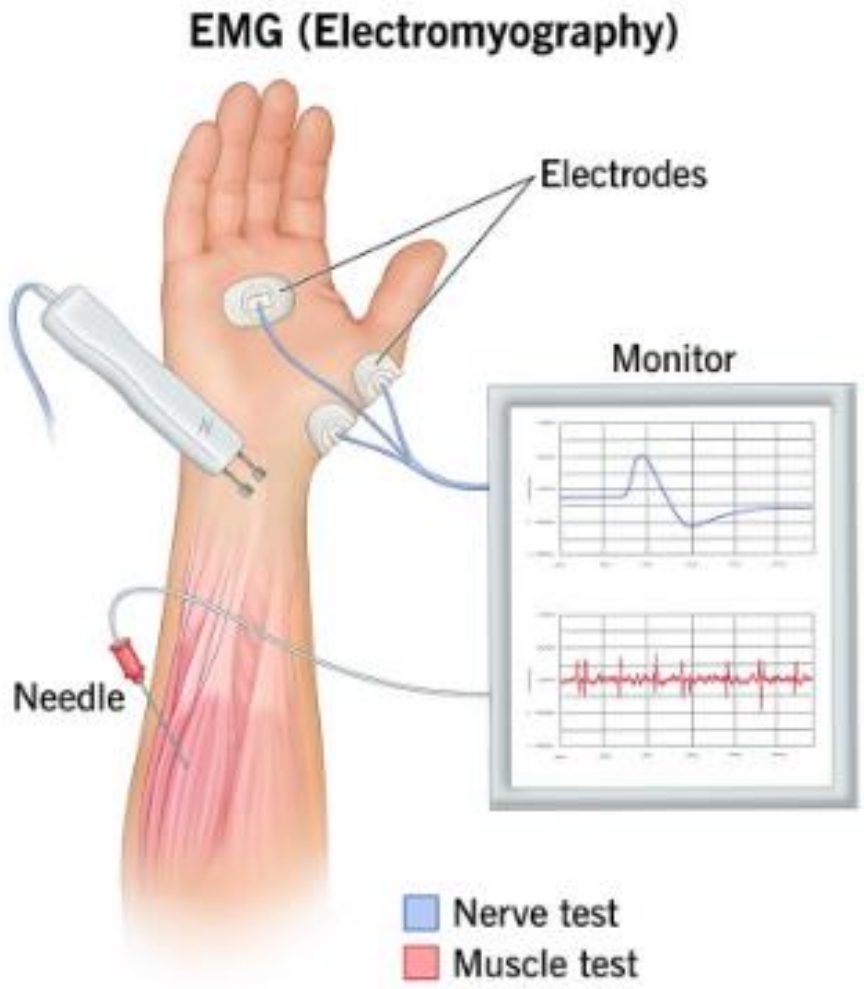


2. **Electroneurogram:** A test used to visualize directly recorded electrical activity of neurons in the central nervous system or the peripheral nervous system

EXAMPLES OF BIOLECTRIC SIGNALS /2

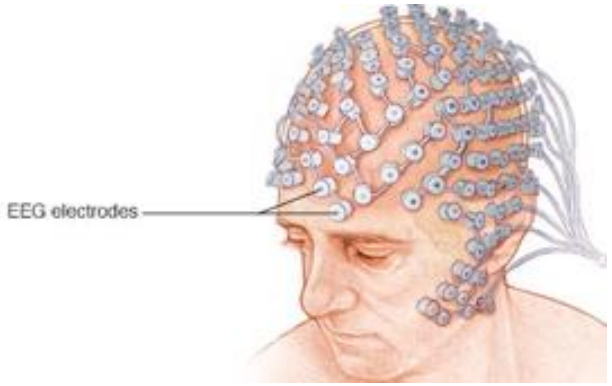
3. **Electromyogram (EMG):** A test that records the electrical activity of skeletal muscles to evaluate nerve and muscle function.

   Neurologists use electromyography (EMG) to help diagnose injuries and conditions that affect your muscles and the nerves that control them



EXAMPLES OF BIOLECTRIC - ELECTROENCEPHALOGRAM

4. **Electroencephalogram:** A test that measures electrical activity in the brain.



5. **Electrooculogram (EOG)** measures the cornea-positive standing potential relative to the back of the eye.