A. CONTROL THEORY: NEGATIVE FEEDBACK SYSTEMS (STABLE)

1. **Controlled variable** - a system variable that is measured and controlled.

2. **Sensor** - a device that measures the current value of the controlled variable. The output of the sensor is an input to the controller.

3. **Set point** - the value of the desired level of the controlled variable. The set point is another input to the controller.

4. **Controller** - a device that receives inputs from the sensor and the set point. The output of the controller is termed an **actuating signal**. Some controllers have an internal component called a comparator that is responsible for the calculation of the **error signal**. In a controller with a comparator, the value of the error signal equals the value of the set point minus the current value of the controlled variable (as measured by the sensor). Another internal component of the controller is responsible for calculating the value of the actuating signal. The value of the actuating signal is a complex function of several variables. In a controller with a comparator, one of the variables used to calculate the actuating signal is the error signal. Other controllers do not have comparators. These other controllers function as if they have a comparator and calculate actuating signal output using other types of components.

5. **Effector** - a device controlled by the actuating signal that produces an adaptive change in the controlled variable.

6. **Steady state** - the system is in steady state when the current level of the controlled variable is near the set point for a reasonable length of time. For controllers with comparators this occurs when the absolute value of the error signal is small for a reasonable length of time. The absolute value of a real number is the magnitude of that number without its sign. For many physiological systems at steady state, the steady-state value of the actuating signal is not zero.

7. A **negative feedback system** utilizes a controller that plays a key role in keeping the current level of the controlled variable near the set point. Some controllers have an internal device called a comparator that **subtracts**.

8. A negative feedback system that is working properly with functional connections and components is termed a **closed-loop system**. When a closed-loop negative feedback system is working properly, a change in the value of the controlled variable that moves the controlled variable away from the value of the set point leads to a corrective change in the value of the controlled variable to move it back toward the value of the set point. These corrective changes serve to keep the value of the controlled variable close to the value of the set point. For controllers with comparators, an increase in the absolute value of the error signal leads to a corrective change in the value of the controlled variable that leads to a decrease in the absolute value of the error signal.

9. When a specific connection or component of a negative feedback system is destroyed, disabled, or no longer responsive to changes of inputs to that connection or component so that information no longer flows around the entire loop (and the rest of the system is still normal), the system is termed an **open-loop system**. In an organism, an open-loop system may occur after certain experimental manipulations or as a result of certain diseases. In an open-loop system, a change in the value of a controlled variable will **NOT** lead to a corrective change in the value of the controlled variable.

B. CONTROL THEORY: POSITIVE FEEDBACK SYSTEMS (UNSTABLE)

1. **Output variable** - a system variable whose value is changed when the output of the effector is changed.

2. **Sensor** - a device that measures the current value of the output variable.

3. **Amplifier** - a device that either adds the current value of the output variable to a previous value of the output variable or a device that **multiplies** the current value of the output variable by a constant number. The output of the amplifier is termed the **actuating signal**.

4. **Effector** - a device controlled by the actuating signal that produces a change in the output variable.

5. **Plateau** - the maximum value of the output variable that can be produced by the effector.

6. **Threshold** - if the value of the output variable exceeds **threshold** value, the system will automatically drive the value of the output variable to plateau.

7. A **positive feedback system** utilizes an amplifier that **adds** or **multiplies**.