

Medi211

Week One – Control Theory

Homeostasis:

- Regulation of the physical, chemical and thermal status of a cell within an organism
- Maintains internal environment in a way that is compatible with life
- Basis of physiology in our lives
- It is essentially a reaction to an external stimulus of which causes an imbalance
- 5 step process:
 - Stimulus: produces change in variable
 - Receptor: detects this change
 - Input: information sent along afferent pathway to control centre
 - Output: information sent along efferent pathway to effector
 - Response: the effector feeds back to reduce the effect of the stimulus and return the variable to homeostatic conditions

Physiological Control:

- Something we directly control – ie: heart rate, breathing etc
- Controlled by effectors – ie: heart, lungs etc
- Involves modifying physiological functions to support life
- Less strict parameters than physiological regulation

Physiological Regulation:

- Something that is not directly controlled but rather regulated
- Involves controlling a physiological function (ie heart rate) in order to regulate a variable (ie blood pressure) in order to maintain homeostasis
- Controlled within tight parameters to preserve life
- Things that we regulate are much more stable than those we control due to stricter upper and lower thresholds

Control Systems:

- Control involves interpreting and responding to information where afferent signals are sent by receptors (which initially receive the error)
- It also involves system error identification which is required to generate an appropriate response
- As well as a means through which to react to the error where efferent signals are sent to effectors (which initiate an effect to counteract the stimulus)
- See lec notes for detailed control system diagrams and examples

On/Off Control:

- Effector is either maximally turned on or maximally turned off
- Is not proportional to stimulus
- Constantly overshoots and undershoots

Proportional Control:

- Effector output is directly proportional to stimulus input
- Humans use proportional control
- Steady gradient
- Achieves stable levels (mostly near target)

Negative Feedback Mechanism:

- Output acts to reduce or stop action of stimulus
- Response is directly opposite to input
- Returns a system to homeostasis
- Most homeostatic control mechanisms are negative feedback mechanisms
- EG: blood glucose etc

Positive Feedback Mechanism:

- Output enhances the effect of the stimulus
- Response is the same as the input
- Involves neural anticipatory signal sent to prime the control mechanism (body kick starts response to maintain stimulus)
- Initiated from Autonomic Nervous System
- Purpose is to control infrequent events that do not require regulation
- EG: oxytocin is released during childbirth to cause contractions, as contractions occur, the body increases oxytocin secretion to cause contractions to become stronger and more frequent until baby is born

Redundancy:

- The more critical the thresholds which regulate a variable, the more systems there are dedicated to its preservation
- Failure of one system does not mean failure to regulate the parameter (appetite etc)

Equilibrium:

- Parameter = well regulated
- No energy expense needed

Acclimatisation:

- Setting a new equilibrium
- Changes to normal levels / thresholds to adapt to and preserve life in a new environment
- EG: changes in breathing at higher altitude as oxygen is more scarce than usual