Control and Coordination - Organ systems: Nervous & Endocrine

**HOMEOSTASIS**: the maintenance of a healthy BALANCE of all chemical reactions in an organism - a “steady state”

Any change (STIMULI) to either the external or internal environment gets a quick RESPONSE to maintain this BALANCE. There is constant monitoring and feedback by the NERVOUS and ENDOCRINE systems to ensure this balance or “steady state”.

NORMAL LEVELS: also called reference levels
- an average value for measurement of a body structure or a function

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Normal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body temperature</td>
<td>37 °C</td>
</tr>
<tr>
<td>Blood pH</td>
<td>7.35 (slightly alkaline-basic)</td>
</tr>
<tr>
<td>Pulse – resting heart rate</td>
<td>50 – 100 beats per minute</td>
</tr>
<tr>
<td>Resting breathing rate</td>
<td>16 – 20 breaths per minute</td>
</tr>
<tr>
<td>Blood glucose concentration</td>
<td>0.1% glucose</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>120/80 mm Hg</td>
</tr>
</tbody>
</table>

Normal ranges: an average range close to normal levels
- ex. body temp range: 36.2°C – 37.2°C

BODY TEMPERATURE and HOMEOSTASIS:
- a) too low: muscles SHIVER to raise body temp
- b) too high: blood flow to surface, perspiration (sweat) cools you down

ILLNESS: you may be sick if your body’s levels are no longer in the normal range

- DIAGNOSIS: the process of determining the type of illness a person may have and possibly the cause of the illness

Medical terms used during diagnosis:
- Fever: temp > 37°C
- Hypothermia: temp < 36°C
- Acidosis: low pH (< 7.35) * slight changes of +/- 0.2 pH
- Alkylosis: high pH (> 7.35) can be FATAL
- Tachycardia: fast heart rate
- Bradycardia: slow heart rate
- Hyperventilation: fast breathing rate
- Hypoventilation: slow breathing rate
- Hypertension: high blood pressure
HOMEOSTASIS and FEEDBACK

Homeostasis is accomplished by the body using a NEGATIVE feedback system ex. thermostat on a furnace
- set to proper temperature ex. 20°C
- temp drops below 20, switch ON turns furnace ON
- temp returns to 20, switch OFF shuts furnace OFF

Negative feedback systems: a process that restores conditions to an original state

CONTAINS:
- MONITOR - thermometer
- REGULATOR - furnace
- COORDINATING CENTRE - thermostat

HOMEOSTASIS is maintained by the following two organ systems:
- NERVOUS system (brain and nerves – FAST response)
- ENDOCRINE system (hormones – SLOW response)

WEBSITES:
http://www.acm.uiuc.edu/sigbio/project/nervous/index.html
http://www.madsci.org/~lynn/VH/annotated.html
http://www.innerbody.com/htm/body.html
http://www.biology-online.org/4/1_physiological_homeostasis.htm
http://community-2.webtv.net/essentialhealth/ENVIRONMENTALTOXINS/
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/F/FramesVersion.html

HUMAN NERVOUS SYSTEM
Stimulus: a change in the environment that is detected by the body

ex. bell, normal light (not UV light)

Response: the body's reaction to the stimulus (change)

Control system: enables body to detect stimuli and coordinate a response

- this is done by the NERVOUS system

NEURONS: nerve cells
- specialized cells that use ELECTRICAL signals to communicate with other cells

- The electrical signal is called an IMPULSE. It travels FAST causing a QUICK response.

NERVES: a bundle of neurons
see book page 171 fig 4

DRAW AND LABEL:
THE STRUCTURE OF A NEURON

NEURON WEBSITE:
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/F/FramesVersion.html
Main parts of a Neuron:

- **Dendrites**: receives impulses from outside and carries impulses towards the cell body
- **Axon**: carries impulses away from the cell body
- **Myelin sheath**: fatty white covering around some axons that allows impulses to travel quickly through an axon
- **Terminal knobs**: the part of the neuron that attaches it to another cell
- **Synapse**: the connection (gap) between the terminal knob of one axon and the dendrite of an adjacent neuron

**Neurotransmitters**: chemicals that relay impulses across a synapse from one neuron to another

A neurotransmitter chemical released from one nerve cell attaches to receptor sites on another nerve cell. When enough receptor sites have been filled by the neurotransmitter chemicals, an impulse is initiated in the nerve cell receiving the neurotransmitters.

Psychoactive drugs interfere with either the movement of these neurotransmitter molecules or their attachment to the receptors.

a) **Stimulants**: ex. cocaine, nicotine, and caffeine
   - speed up the action of the central nervous system
   - some prevent the transmitting chemicals from breaking down or recycling
   - neurotransmitters remain on their receptors longer than they normally would and keep the receptor sites on the nerve cell full, resulting in more frequent firing of the nerve cell.

b) **Depressants**: ex. tranquillizers, barbiturates, and alcohol,
   - slow down the action of the central nervous system.
   - some depressants delay the effect of neurotransmitter chemicals by slowing the reaction of connecting nerves.

**Types of Neurons**: (three)

1. **Sensory**: carry impulses from sensory receptors (eye, skin, nose, etc.) to central nervous system
2. **Motor**: carry impulses from central nervous system to effectors (muscles, glands) which cause a response
3. **Interneurons**: link sensory and motor neurons
   - these neurons make up the central nervous system

- The REFLEX ARC: also known as the Withdrawl Reflex
Stimulus → sensory receptor → sensory neuron → interneuron (brain or spinal cord)

response ← effectors (muscles, glands) ← motor neurons

✿ This reflex takes a fraction of a second, for your protection

NERVOUS CONTROL AND HOMEOSTASIS

Human nervous system - two (2) main sections:

- CNS – central: brain and spinal cord (interneurons)
- PNS – peripheral: all other nerves (sensory and motor)

All nerves are coordinated by the CNS.

PNS (peripheral) - this part is further divided into two sections:

- Somatic NS: motor neurons under conscious control and all sensory neurons
  **VOLUNTARY**
- Autonomic NS: motor neurons that function without conscious control
  - This system controls: heart rate, body temperature, pupil dilation, gland secretions
    **All INVOLUNTARY**

Autonomic NS is also divided into two parts:

- Sympathetic NS: prepares the body for DANGER
  - ex. increased heart rate
  - or increased blood flow to muscles
  - this system active during a game
- Parasympathetic NS: returns the body to a normal state after a stressful situation
  - returns heart rate to normal
  - this system takes over after a game

Human nervous system

<table>
<thead>
<tr>
<th>Central NS</th>
<th>Peripheral NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain</td>
<td>spine cord</td>
</tr>
<tr>
<td>Somatic NS</td>
<td>Autonomic NS</td>
</tr>
<tr>
<td>Voluntary</td>
<td>involuntary</td>
</tr>
<tr>
<td>sensory</td>
<td>motor</td>
</tr>
<tr>
<td>Sympathetic NS</td>
<td>Parasympathetic NS</td>
</tr>
<tr>
<td>(danger, action)</td>
<td>(calm, normal)</td>
</tr>
</tbody>
</table>

Human Endocrine System
Hormones: a compound released by one type of cell that has an effect on other cells in the body. These play a MAJOR role in homeostasis. They help regulate and coordinate the functions of all systems in the body.

Glands: specialized cells or organs that MANUFACTURE hormones - they SECRETE hormones into the bloodstream

- The job of the ENDOCRINE system is to aid homeostasis by secreting hormones in the body.

How hormones work:

Hormones affect certain TARGET cells. Each hormone can come in contact with many organs but will only cause an effect if the TARGET organ or cell has the proper HORMONE RECEPTOR to initiate a response.

See book page 174, fig. 10

ex. ADH – AntiDiuretic Hormone
- only affects the KIDNEY
- JOB: to STOP urine production (helps homeostasis by controlling water levels in blood)

TYPES OF GLANDS

See book page 174, fig. 9

Important glands: hypothalamus
pituitary
pancreas
thyroid
parathyroid
kidney
adrenal
ovary & testes

Pituitary Gland – The Master Gland
This gland is located near the base of the brain. It is called the MASTER gland because it secretes more types of hormones than any other gland. This gland secretes hormones that CONTROL the secretion of hormones by other glands.

- Important hormones secreted by the pituitary gland (see book page 175, Table 2)

Pituitary gland: Structure

- made up of two (2) sections:
  - Anterior lobe
  - Posterior lobe

The pituitary gland is controlled by the part of the brain called the hypothalamus.

Hypothalamus: part of the brain (CNS)

- JOB: nerves here stimulate ANTERIOR lobe to secrete hormones
  - also produces hormones that are secreted by the POSTERIOR lobe

1. Nerve cells of hypothalamus produce and secrete hormone releasing factors into blood vessels that lead into the anterior lobe of pituitary.
2. Cells of the anterior pituitary produce and secrete hormones into bloodstream in response to hormone-releasing factors from hypothalamus.
3. Nerve cells of hypothalamus produce hormones that travel down nerve cells and are secreted into bloodstream within the posterior lobe of the pituitary.

see book page 175, fig. 11

Hypothalamus

<table>
<thead>
<tr>
<th>hormone releasing factors</th>
<th>hormones from nerve cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior lobe</td>
<td>pituitary gland</td>
</tr>
<tr>
<td>Posterior lobe</td>
<td></td>
</tr>
</tbody>
</table>

secretion of major hormones
made by anterior lobe

secretion of hormones
made by hypothalamus

Fight or Flight Response: The ADRENAL gland
This is a good example of how the nervous and endocrine systems work together.

**FIGHT:** Sympathetic NS prepares for danger:

- Nerves also stimulate ADRENAL gland to produce and secrete the hormone ADRENALINE. This hormone helps maintain and enhance changes caused by the sympathetic nerves.

Together, the sympathetic NS and adrenaline have this affect on the body:

- increased heart rate, blood vessels contract in skin, more blood to muscles, muscle tension, perspiration

**REVERSE:** Parasympathetic nerves take over to calm body down after stressful situation ends.
The adrenal gland has stopped producing adrenaline

This shows how nerves and hormones work together to maintain *homeostasis*.

- **Comparing the Nervous and Endocrine Systems**

<table>
<thead>
<tr>
<th>Nervous system</th>
<th>Endocrine system</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) message carried through NERVES as an electrical IMPULSE</td>
<td>message carried by a chemical (HORMONES) through BLOODSTREAM</td>
</tr>
<tr>
<td>b) response = FAST - lasts seconds</td>
<td>response = SLOWER - lasts longer (minutes, hours)</td>
</tr>
</tbody>
</table>