Lecture 1

Physis = “nature”; ology = “study of”

Study of how & why

Mechanisms:

Cause & Effect
Physical & chemical factors responsible for vital human functions

* Incorporates: Anatomy, Chemistry & Physics

HOMEOSTASIS:

- Homeo = "same, alike"; Stasis = "standing"
- Maintenance of an internal constancy

~ Walter Cannon:
1871 – 1945 (1932)

Importance:

- Provides physiology a framework for study
- Function & processes are designed to: maintain dynamic consistency
Health:

- Determined by the body’s ability to maintain homeostasis
- **ALL** Body parameters (measurable value) subject to change are evaluated
- **ALL** Body parameters evaluated against the “Normal variance” or “Normal Range”

"Normal": Healthy Blood composition

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial pH</td>
<td>7.35-7.45</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>24–28 mEq/L</td>
</tr>
<tr>
<td>Sodium</td>
<td>135–145 mEq/L</td>
</tr>
<tr>
<td>Calcium</td>
<td>4.5–5.5 mEq/L</td>
</tr>
<tr>
<td>Oxygen content</td>
<td>17.2–21.0 ml/100 ml</td>
</tr>
<tr>
<td>Urea</td>
<td>12–35 mg/100 ml</td>
</tr>
<tr>
<td>Amino acids</td>
<td>3.3–5.1 mg/100 ml</td>
</tr>
<tr>
<td>Protein</td>
<td>6.5–8.0 g/100 ml</td>
</tr>
<tr>
<td>Total lipids</td>
<td>400–800 mg/100 ml</td>
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<td>Glucose</td>
<td>75–110 mg/100 ml</td>
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- Maintenance of Homeostasis:
  - Components:
    1. **Sensors**: Tissues which detect changes in body parameters
       - Nervous & glandular tissue

Hypothalamus: Thermosensitive neurons
Gage changes against a reference value:

**Set Point**

- Determined as: *AVERAGE central value*

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2. **Integrators (Control Center):** Tissues which evaluate parameter deviations

- **Central Nervous System & Glands**

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**Integrators:**

- Exercise: Increase in body heat
- Anterior Hypothalamic nucleus
- Evaluate: **Degree & Direction of deviation**

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3. **Effectors**: (Compensating tissues)

- Tissues opposing/correcting deviation
  - Muscle & glands
- Function: Re-establish/defend set point

![Diagram of temperature regulation]

**Mechanism: Negative Feedback**

- Maintains: All homeostatic parameters
  - Effector activity opposes the stimulus
  - Effectors have a “corrective action”
    - Try to re-establish set point

![Diagram of negative feedback loop]
**Compensate for imbalance**

- Eating
- Blood glucose
- Pancreatic islets (of Langerhans)
- Insulin
- Cellular uptake of glucose
- Blood glucose

**Result: Dynamic Constancy**

- NOT constant BUT variable within **limits**
- Limits: “Normal Ranges”
- Average parameter variance
- Central Value: Set point
Generally Homeostasis involves:

2 antagonistic effectors

- Sweating
- Shivering

Result: Maintenance of "Dynamic Constancy"
- Deviations from set-point are corrected

Mechanism: Negative feedback

Target: All parameters subject to change

WHY ??????
- Maintain Optimum running environment

Summary: Homeostasis

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Disease:

- “Inability to compensate for deviation”
  - Incapable of maintaining homeostasis
  - Non-optimal running environment
    - Old age
    - Genetic Mutations
    - Malnutrition
    - Pathogens: bacterial / viral / fungal
    - Environmental conditions
    - etc.

Health: Contingent upon the ability to:

a. Sense & integrate deviations
b. Initiate correct effector responses
   - Re-establish dynamic consistency

~ Normal Blood sugar: 75mg – 100mg / 100ml
**Diabetes Mellitus:**
- Inability to regulate blood sugar

**Positive Feedback:**
- Feedback amplifies change until stimulus is gone
  - *Effectors increase stimulus*
    - Blood clotting response
    - Parturition
  - Increase rate of change
  - BUT does NOT by itself maintain homeostasis

Examples: Blood Clotting and Child Birth

**Positive Feedback: Child Birth**
- Oxytocin stimulates muscular contractions of the uterus
- More oxytocin is released
Chemistry Review:

- Molecule Measurements:
  1. Gram molecular weight: Mole
  2. Solution Concentration: Molality

Mole:

- Unit of Atomic / Molecular Measurement
  - Number of Molecules within 22.4 liter of gas at standard temp. and pressure
  - Amount of substance expressed in grams containing as many atoms

1. Gram molecular weight

- Combined atomic weight of one mole of particles (atoms or molecules)
  - Calculate the formula weight in grams
    example: 1 mole of ethylene = ____ grams
    \( \text{C}_2\text{H}_4 \) (ethylene)
1 mole of ethylene = ____grams

C: Atomic mass = 12.01
H: Atomic mass = 1.01

Gram Molecular Weight: 1 mole ethylene

\[
\begin{align*}
12.01 \times 2 &= 24.02 \\
1.01 \times 4 &= 4.04 \\
\text{sum} &= 28.06 \text{ gms}
\end{align*}
\]

\[\Rightarrow 1 \text{ mole of ethylene} = 28.06 \text{ gms}\]
Practice:

> **Gram Molecular Weight? Glucose C₆H₁₂O₆**

1. mole of glucose = _____ grams

Practice:

> **Gram Molecular Weight? Glucose C₆H₁₂O₆**

\[
\begin{align*}
12.01 \times 6 &= 72.06 \\
16.00 \times 6 &= 96 \\
1.01 \times 12 &= 12.12 \\
\text{sum} &= 180.18 \text{ gms}
\end{align*}
\]

1. mole of glucose = ~180 grams

Practice:

> **Gram Molecular Weight? NaCl**

\[
\begin{align*}
22.99 \times 1 &= 22.99 \\
35.45 \times 1 &= 35.45
\end{align*}
\]

1. mole of NaCl = 58.44 grams
2. Solution Concentration:

- **Solution:** homogeneous mixture of 2 (or more) substances in one state
  
a. **Solvent**
b. **Solute**

- Solid liquid or gas

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a. **Solvent:** liquid

- Molecule present in greatest amount

  * **Causes** distribution or dissociation of another substance
**Distribution**: Spreading out of molecules – NO bonds broken

- **Glucose** (Solute)
- **Water** (Solvent)

**Dissociation**: Separating of molecules – breaking bonds

- **Salt (NaCl)** (Solute)
- **Water** (solute)

b. **Solute**:

- Molecule present in *lesser amounts*
- Subject to *distribution or dissociation*
Water: Best known biological solvent

A. Quantity:
- Living organisms typically 70%–95% water
  - Greatest Concentration
  - Water diffuses between molecules
  - Distribute – Spread out molecules

B. Polar molecule: Separation of charge within neutral molecule
- Slightly negative
- Slightly positive
- Polarity allows water to orient around ions
- Large numbers of water overwhelm & break ionic bonds
**Dissolution of Sodium Chloride**

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**Solution Concentration:**
- Expressed as *concentration of solute*
  - Units: **Molality** (m):
    - Moles of solute per liter of solvent
    - Solute added to 1 liter (1Kg) H₂O

- Resulting solution is *greater than a liter*
Molarity calculations

- **1 m Glucose =**
  1 mole glucose / 1 L H₂O
  180g glucose / 1 L H₂O

- **2 m Glucose =**
  2 moles glucose / 1 L H₂O
  360g glucose / 1 L H₂O

- **1 m NaCl =**
  1 moles glucose / 1 L H₂O
  58.44g glucose / 1 L H₂O

\[\text{Molarity (M): Moles solute per liter of solution}\]

\[\text{Reflects the exact number of solutes introduced per 1 L H₂O}\]
Which solution = ONE molal (m)?