

***Biology 160
Human Anatomy
and Physiology***

San Diego Mesa College
Spring 2010
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Agenda

- Introductions & Syllabus
- Basics of Anatomy & Physiology
- Hierarchy of Organization
 - Atoms & Molecules
- Homeostasis

***Introduction to Anatomy &
Physiology***

- What is . . .
 - Anatomy ?
 - Physiology ?
- What are the life processes that are integrated into the study of anatomy & physiology?

The studying of A&P

- How does one study this subject?
 - mechanistic vs. teleological approaches
 - tools of the trade
 - from scalpels to computers
- Why study A&P?

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Divisions of Anatomy & Physiology

- Gross vs. Microscopic Anatomy
- Anatomy specialties...
 - Surface, regional, systemic, developmental. . .
- Physiology specialties...
 - Cell, special (organ level), systemic, patho, exercise, ...

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Where to start? Levels of Organization

Small/Simple

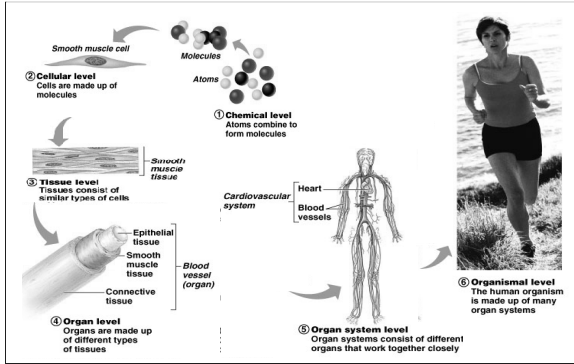


- Chemical Level
 - atoms form molecules
- Cellular level
 - cells and their functional subunits
- Tissue level
 - a group of cells performing a common function
- Organ level
 - a discrete structure made up of more than one tissue
- Organ system
 - organs working together for a common purpose
 - There are 11 basic organ systems
- Organismal level
 - the result of all simpler levels working in unison
- ???

Large/Complex

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Levels of Structural Organization



Basic chemistry for A&P

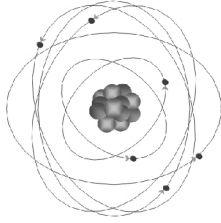
- What is essential to know?
 - Structure of an atom
 - Types of bonds and how it relates to atomic structure (electron shells)
 - Basic energy reactions
 - Inorganic compounds
 - Organic compounds
- Why do we need to know this?
 - It relates to everything that goes on within a cell, both in structure and function!

Atoms

- Atoms are the smallest building blocks of matter
 - Matter is anything that has mass and takes up space
 - Three phases of matter:
 - Solid
 - Liquid
 - Gas
- Size: small!!!!
 - The largest is only .5 nm (.000000005m or 5×10^9 m)

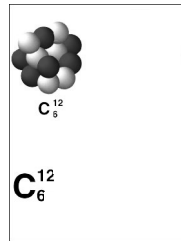
Atomic Structure

- Atoms are composed of three main particles (subatomic)
 - Protons (p⁺)
 - Neutrons (n⁰)
 - Electrons (e⁻)
- Location of subatomic particles
 - Protons & neutrons are located in the nucleus of the atom
 - Electrons are located in the electron cloud (think of as thick layered shells)



Atomic terms

- Atomic number
 - the number of protons in an atom's nucleus
- Mass number (atomic mass)
 - Total number of protons and neutrons in the nucleus
 - Different mass numbers indicate different **isotopes**
- What good is the period table of elements?



Periodic Table of the Elements

I																0															
H																He															
Li Be																B C N O F Ne															
Na Mg																Al Si P S Cl Ar															
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr																III IV V VI VII															
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe																															
Cs Ba La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu																															
Fr Ra Ac Unq Unp Unk Uns 108 Uue																															
Lanthanide Series																Actinide Series															
Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu																Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr															

Electron Shells

- Electrons “orbit” the nucleus of an atom in an electron cloud
 - This cloud is best freeze framed and viewed as electron shells
 - Different shells have different numbers of electrons in them and all shells want to have a stable number of electrons
 - Unstable shells attract or give off electrons to become stable!
 - This brings us to bonding

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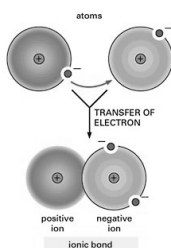
Chemical Bonds & Compounds

- Chemical compounds are formed when two or more atoms form a bond
- The shells of atoms that are not stable gain stability by sharing, gaining or losing electrons in chemical reactions
- Molecules vs. compounds
 - Molecules are chemical structures made of more than one atom (of the same variety) bonded together
 - Compounds are made of two or more different atoms that are formed during chemical reactions
 - The compound may have VERY different properties than either atom (ex. H and Cl molecules)

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Ionic Bonds

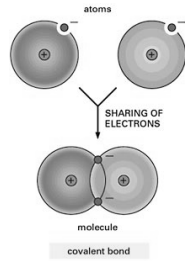
- Ionic bonds are created by an electrical attraction between anions (negatively charged atoms) and cations (positively charged atoms) ex. Na⁺Cl⁻, formed when electrons are gained or lost



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Covalent Bonds

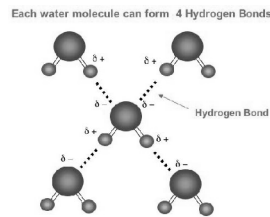
- Covalent bonds are created by two atoms sharing electrons to satisfy shell requirements
 - If the atoms share only a single pair of electrons it is a single bond, if two pair – a double bond, if 3 pr. – triple
 - The bonds may be non-polar (no charge on the compound) or polar (with a charge – due to unequal sharing of electrons), or amphipathic (with a polar and non polar region)



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Hydrogen Bonds

- Weak forces of attraction between atoms and molecules.
- With hydrogen's slightly positive nature (short an electron), it is attracted to the weakly negative charge of oxygen or nitrogen in a polar covalent bond
- Hydrogen bonding forces are too weak to form new compounds, but can alter shape or create surface tension



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Chemical Reactions & Energy

- Chemical reactions occur as new bonds are formed or broken from initial compounds (**reactants**) forming new compounds (**products**)
- The summation of all chemical reactions in the body is called **metabolism** and is a summation of:
 - Anabolic (synthesis) reactions** – building compounds
 - Requires energy
 - Ex. dehydration synthesis
$$AB \rightarrow A + B$$
 - Catabolic (decomposition) reactions** – splitting compounds
 - Releases energy
 - Ex. hydrolysis
$$AB \rightarrow A + B$$
 - Exchange reactions** – reactant molecules are rearranged

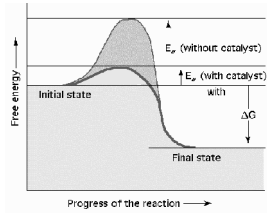
$$AB + CD \rightarrow AC + BD$$

A double ended arrow signifies a reversible reaction
the direction the reaction proceeds depends on the quantities of reactants and products

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Reaction rates & Catalysts

- Reactions require energy to start = activation energy
- Catalysts are compounds that accelerate the reaction but are unchanged by it and can be reused.

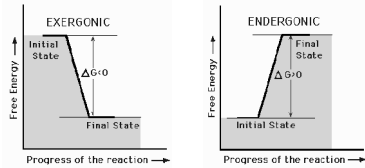


*Biological catalysts are referred to as enzymes

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Exergonic vs. Endergonic Rxns

- If a reaction proceeds and releases more energy than is used, it is said to be **exergonic**
- If a reaction proceeds and requires more energy than is released, it is said to be **endergonic**



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Inorganic vs. Organic Compounds

- Inorganic
 - Small compounds usually don't contain C or H
 - CO₂, O₂, H₂O, inorganic acids & bases, salts (main inorganic compounds)
- Organic
 - Larger more complex molecules
 - may contain hundreds of thousands of atoms
 - Composed mainly of H and C (fats, carbohydrates, lipids, proteins, nucleic acids, nucleotide based energy compounds)

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Homeostasis

- What is homeostasis?
 - The operation of an organism within set physiological limits, i.e. creating a stable environment for **all levels** of structure to operate within
- How is homeostasis maintained?
 - Regulation of homeostasis is maintained by feedback systems
 - Positive vs. Negative
 - Feedforward

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Homeostasis – requirements...

- Something needed to monitor the required environment
 - **A receptor (1)**
- Something to process the information from the receptor
 - **A Control or integration center (2)**
- Something to respond to commands from the control/integration center
 - **An effector (3)**

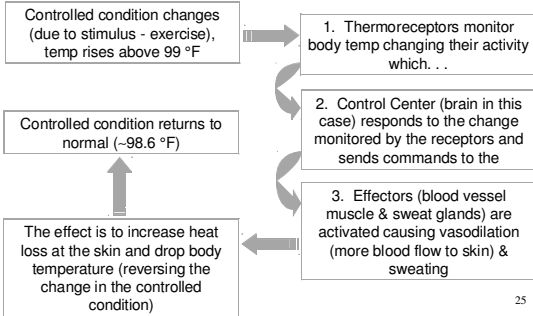
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Homeostatic Feedback Loops

- Negative Feedback Loops
 - The change in the controlled (monitored) condition starts a series of events that corrects that change back to normal.
 - This is the most common mechanism to maintain physiological limits (temp, blood gas levels, osmotic balance...)
 - Example: thermoregulation

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Thermoregulation



Homeostatic Feedback Loops

- Positive Feedback Loops
 - The change in the controlled condition caused by a stimulus produces a response that reinforces (is positive) the stimulus
 - Common or Rare Loop?
 - Quite rare as it can be extremely hazardous if applied wrong....
 - apply it to thermoregulation and it will kill you
 - apply it to blood clotting and it will save you!
 - Other examples?

Homeostatic Feedback Loops

- Feedforward mechanism
 - Creates a change in the system ahead of the actual event
 - A homeostatic loop involved in preparation
 - ex. cephalic phase of digestion
 - You see, think, smell food &....



Failure of Homeostatic Mechanisms

- Depending on the level of failed homeostasis
 - Creates disease and possibly death without intervention.
